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AN EVALUATION OF THE
TRAFFIC ENGINEERING FUNCTIONS
IN THE SMALL MUNICIPALITIES
OF INDIANA

James R. Mekemson



PURDUE UNIVERSITY
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AN EVALUATION OF THE TRAFFIC ENGINEERING FUNCTIONS IN THE SMALL MUNICIPALITIES OF INDIANA

Attached is a Final Report by Mr. James R. Mekemson, Graduate Instructor in Research on our staff, titled "An Evaluation of Traffic Engineering Functions in the Small Municipalities of Indiana". The Report is on the JHRP Research Study titled "Traffic Engineering in the Small Communities of Indiana". Professor K. C. Sinha of our staff directed the research and guided preparation of the Final Report.

The Report is presented as the Final Report on this Study for acceptance as fulfillment of its objectives.

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Final Report

AN EVALUATION OF THE TRAFFIC ENGINEERING FUNCTIONS
IN THE SMALL MUNICIPALITIES OF INDIANA

by

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ABSTRACT

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Indiana, like many other states, has a large number of small cities and towns. On the streets of these municipalities, drivers encounter differing levels of traffic engineering, resulting in confusion, frustration, as well as possibly hazardous conditions. However, very little effort has been expended in the past in quantifying the level of traffic engineering that exists in these communities. But only when the present situation about the traffic engineering functions is appropriately ascertained, can the possible needs to improve the functions be determined.

This research project sought to find out what level of traffic engineering is presently being performed in those cities and towns of Indiana whose population is between 2,000 and 50,000 persons. This information was needed so as to determine in what areas of traffic engineering additional financial and educational aid was needed in order to improve the quality and quantity of the traffic engineering services performed.

In order to obtain this information, a questionnaire survey, a personal interview, and a traffic control device survey was conducted in a total of twenty six cities and towns throughout the state of Indiana.

The summaries and analyses of the data showed that in general, as the population size of the municipality decreased, there was a corresponding decline in the quantity and quality of the traffic engineering functions performed. This relationship was best illustrated by the conformance of the traffic signs to the standards as set forth in the Manual on Uniform Traffic Control Devices.

The most important result of the research was the revelation of the general lack of knowledge of the people in charge of the traffic engineering functions. Not only did they lack the knowledge of how to properly perform the traffic engineering functions, but also the knowledge of from where they could get the information on how to perform the functions.

CHAPTER I

INTRODUCTION

Like many other states, Indiana has a large number of small cities and towns. In these municipalities, drivers encounter differing levels of traffic engineering, resulting in confusion, frustration, as well as hazardous conditions. However, very little effort has been expended in the past in quantifying the level of traffic engineering that exists in these communities. But, only when the present situation is appropriately ascertained, can the possible needs to improve the functions be determined.

Depending upon the size and governmental organization of the municipality, the traffic engineering functions that are performed by the municipality may include one or more of the following activities.

1. Traffic surveys, condition surveys, accident studies, and determination of need studies.
2. Developing city wide operation plans and programs.
3. Participation in the design of new transportation facilities.
4. Regulation of street use by transit and other public carriers, and coordination with auto traffic.
5. Participation in transportation planning.

6. The formulation of traffic control regulations, such as one way streets, turning movement prohibitions, speed limits, and channelization.
7. Regulation of other street uses, such as driveway entrances, construction storage, street closure, parades, and structures on right-of-way.
8. Control of street parking and installation of meters, signs, and other devices used to exercise control.
9. Design and regulation of off-street parking facilities.
10. Design and control of traffic signal systems.
11. Design and control of traffic signs, street signs, and street markings.
12. Design and control of street lighting systems.

Most of the traffic engineering functions listed above are usually associated with the larger urban areas with their multitude of intersections, traffic signals, and congested arterials. In such cities, the traffic engineering function is an obvious necessity. The budgets of these larger cities are big enough to support the functioning of a traffic engineering department with the necessary technical personnel on a full time basis.

Traffic engineering problems also exist in the smaller cities and towns. The same problems of congestion, accidents and other traffic related problems exist, but in a lesser

extent. The comparatively smaller tax bases of the small municipalities, in most cases, preclude the services of a traffic engineering department on a full time basis. On the other hand, even if the monetary sources were available from the municipality's budget, there probably would not be enough work for a full time professional traffic engineer.

In small municipalities, the traffic engineering function is therefore usually handled by either a police official, city or town engineer, street commissioner, or by some other city or town official.

These municipalities, thus, do not have the benefit of in-house expertise to analyze and implement an effective traffic engineering solution. Under these circumstances, the municipality may overreact, underreact, or do nothing for any given traffic engineering problem or situation.

Previous nationwide studies of the traffic engineering functions being performed in cities have concentrated on only cities of larger populations of usually 50,000 and more people. Smaller cities and towns of under 50,000 population were almost completely ignored by these studies.

In the state of Indiana, only five percent of the cities and towns have a population of greater than 50,000, with seventy percent of the cities and towns being within the 2,000 to 10,000 population range.¹ In addition, there

are also many communities whose population is less than 2,000 people. In Figure 1 is shown the cumulative distribution of those cities and towns of Indiana whose population is between 2,000 and 50,000 people.

The objectives of this research project were to seek the answers to three basic questions concerning traffic engineering services in the small cities and towns of Indiana whose population is between 2,000 to 50,000 people.

1. What is the minimum level of traffic engineering services required for a small city or town of a given population size?
2. What is the most effective procedure to provide this traffic engineering service?
3. What are the benefits in providing this traffic engineering service to the municipality?

Another important result of this research project is the knowledge of the present traffic engineering functions being performed in the various small cities and towns of Indiana. Other possible positive effects would depend upon implementation of any of the recommendations made as a result of this study. These possible benefits would be the reduction of traffic accidents; the reduction of expenditures on unwarranted traffic control devices; proper installation of warranted traffic control devices; better observance by the motorist of warranted and properly installed traffic control devices; removal of nonstandard or unwarranted

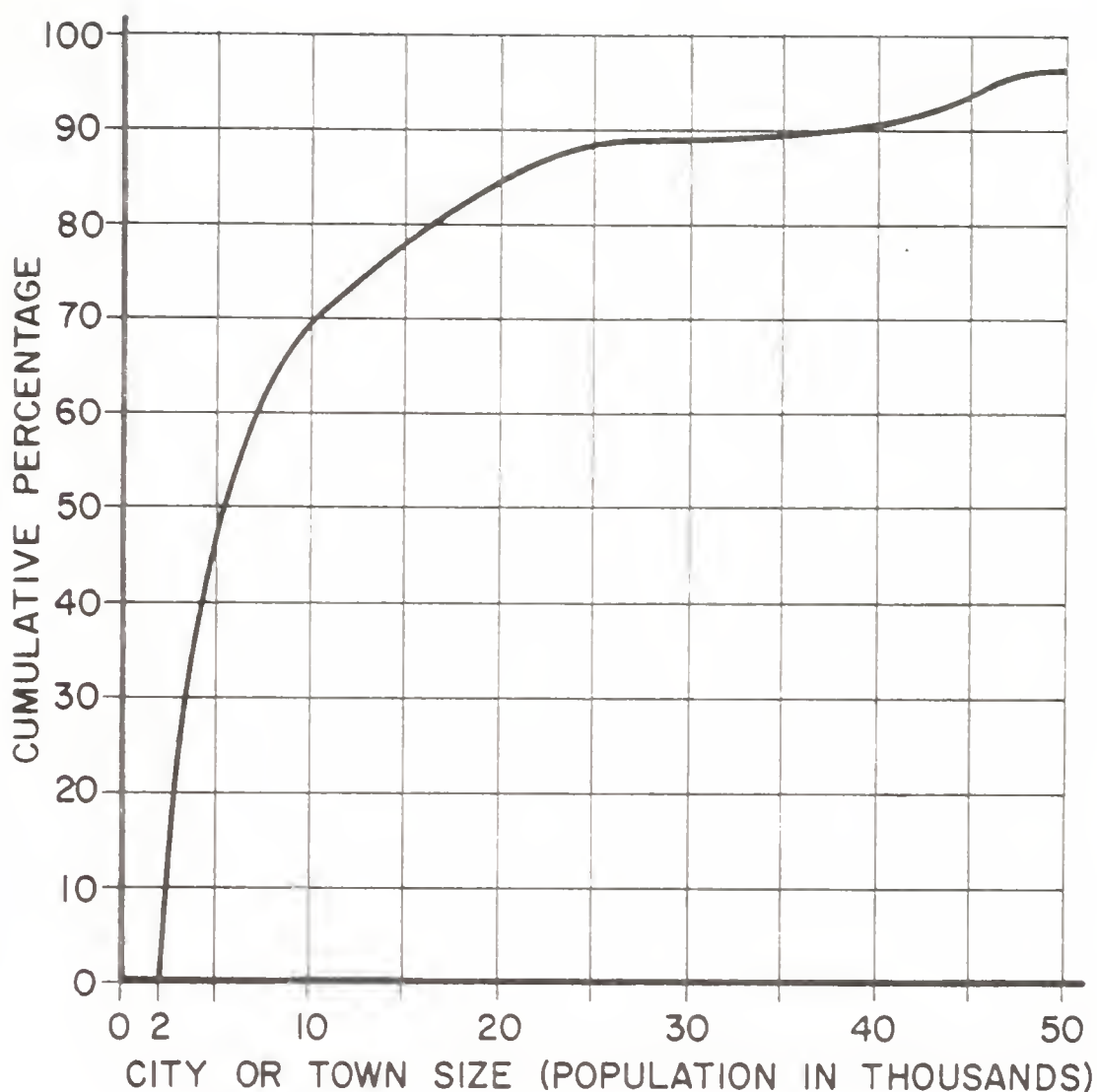


FIGURE 1. CUMULATIVE PERCENTAGE DISTRIBUTION OF CITY AND TOWN POPULATIONS BETWEEN 2,000 AND 50,000 .

traffic control devices; and therefore, an increase in overall driver confidence due to better traffic engineering administration. Two other possible benefits that are very relevant at the present time are the eventual decrease in both energy consumption and air pollution due to the removal of or prevention of unwarranted traffic control devices that may cause unnecessary delays.

CHAPTER II

DATA COLLECTION AND ANALYSIS PROCEDURE

In order to achieve the objectives of this project, a work plan was established consisting of the following steps.

1. Examination of what traffic engineering functions are presently being performed and the level of support with respect to city or town size.
2. Identification of who or what department is responsible for the administration of the traffic engineering functions with respect to city or town size.
3. Evaluation of the effects (benefits and disbenefits) of the traffic engineering functions performed with respect to the administration and city or town size.
4. Determination of what traffic engineering functions and activities should be performed and the suggested level of support with respect to city or town size.
5. Determination of who or what department should or could administer the traffic engineering functions with respect to city or town size.

6. Formulation of recommendations regarding how these minimum levels of support and administration can be implemented.

City and Town Selection Process

Population ranges and the number of cities and towns to be sampled within each population range were primarily determined on the basis of the city and town population distribution shown previously in Figure 1. The population ranges finally selected, the actual number of cities and towns within each range, and the number of cities and towns sampled within each range for which a complete set of data was collected, are shown in Table 1.

Table 1

Population Ranges, the Number of Cities and Towns Within Each Range, and the Number of Cities and Towns Sampled From Each Range in Which Complete Data Was Collected.

| Population Range | Cities and Towns Within the Population Range | Cities and Towns Sampled Within the Population Range |
|------------------|--|--|
| 2,000 - 9,999 | 120 | 7 |
| 10,000 - 19,999 | 26 | 4 |
| 20,000 - 50,000 | 17 | 6 |

Cities and towns chosen to be studied were selected randomly within the population ranges. There was, though,

one constraint that decreased the initial size of the sample space. This constraint involved the reduction of unnecessary travelling associated with the data collection process. Consequently, no sampling was done from the cities and towns located in approximately the southern one-fifth of the state of Indiana.

A few of the cities sampled were not chosen randomly. This was due to the fact that one of the population ranges has a small sample size to choose from and secondly, because complete data sets from some of these cities were not made available for this study. Some of these incomplete data sets were also used in the analysis when possible.

Questionnaire Preparation

It was determined early in the study that a large part of the data collected would involve a questionnaire survey conducted through a postal survey with a follow-up personal interview.

In the preparation of the questionnaire, consideration was given to the fact that great differences in governmental organization exists among the cities and towns, and therefore, the manner in which the traffic engineering functions are administered also varies greatly among the cities and towns. These differences necessitated the development of a relatively simple questionnaire from which necessary comparisons of the various functions could easily be made.

Another consideration in the development of the questionnaire was that the smaller cities and towns do not usually keep records broken down into as great a detail as the larger cities and towns.

The major areas in which information was desired to be gained from the survey were as follows.

1. Traffic engineering administration and personnel.
2. Traffic accident records on local streets.
3. Expenditures for maintenance and erection of traffic control devices.
4. Special financial assistance received from outside government agencies.
5. Studies and surveys.
6. Controls on local curb use.
7. Responsibility for determining needs, design, and locations of traffic control devices.
8. Traffic engineering related inventories.

A copy of the entire questionnaire in its final form can be found in Appendix A.

Survey of Traffic Control Devices

In addition to the information obtained from the questionnaire survey and the personal interview, it was decided that an objective type of measurement of the overall quality of the traffic engineering services provided in each of the municipalities considered was

needed. After careful consideration of various parameters that could be easily quantified, it was decided that a survey of the traffic control devices in regards to both their conformance to the Manual on Uniform Traffic Control Devices and as to their physical condition would be made.² The main reason for choosing this type of survey is because of the importance of traffic control devices in conveying regulatory and warning messages essential to the motorist in his effort to drive safely and efficiently.

The field observations from the survey of traffic control devices were converted into two common indices, the Conformance Index and the Physical Condition Index for each municipality sampled. These indices could then be used as indicators of how well and to what extent the traffic engineering services were being administered. The Conformance Index also provides information as to the conformance of the traffic control devices to the Indiana State Statutes, and therefore, is an indicator of the possible legal liabilities of the individual cities and towns. In this regards, statistical tests were later made to see if correlations exist between traffic accidents and the indices. Statistical tests were also made between traffic accidents and other parameters determined from the questionnaire survey.

The Conformance Indices and the Physical Condition Indices were determined separately for each of the three

types of traffic control devices, signs, signals and markings for each city and town surveyed. The procedures used for calculating the Conformance Index and the Physical Condition Index is discussed in the following section.

Conformance and Physical Condition Index Calculations

The three Conformance and Physical Condition Indices, one each for signs, signals and markings were determined as follows for each of the cities and towns sampled.

1. Intersections within a city or town were randomly chosen for sampling. Intersections of local streets not under state jurisdiction were sampled only, because the Indiana State Highway Commission has the responsibility of the installation and maintenance of all traffic control devices on state highways and at intersections of state highways with local streets.
2. Each sign that was related to the intersection in terms of either pedestrian or vehicle movements at that particular intersection was counted as one sign.
3. Each signal face, either for pedestrian or vehicular traffic, that was related to the intersection was counted as one signal.

4. Each pavement marking or marking set, such as turn arrows or crosswalk lines, that was related to the pedestrian or vehicular movements at that particular intersection was counted as one pavement marking.
5. Each sign, signal, and marking that was related to the pedestrian and vehicular movements at the intersection was compared to the standards as found in the Federal Highway Administration's Manual on Uniform Traffic Control Devices. Each nonconformance of the traffic control device to the manual was counted as one nonconformance. Any one particular traffic control device could have more than one nonconformance associated with it. For example, a sign could be of the wrong shape, color, size, mounted height, wording, or design.
6. A traffic control device with a physical condition that required repair, maintenance, or replacement counted as one poor physical condition. Any one particular traffic control device could not have more than one poor physical condition counted for it. If a traffic control device had a nonconformance requiring replacement and a poor physical condition, the traffic control device was counted as having both a nonconformance and a poor physical condition.

7. The Conformance Indices were calculated for each city and town by dividing the total number of non-conformances for each of the three types of traffic control device by the total number of each respective type of traffic control device observed at the sampled intersections. For example, if a city with a total of one hundred signs located at the intersections sampled had a total of one hundred fifty nonconformances associated with those one hundred signs; the Conformance Index is then calculated as follows:

| | |
|---------------------------------|-----|
| Number of signs | 100 |
| Number of nonconformances . . . | 150 |
| Conformance Index | 1.5 |

A Conformance Index of zero (0) would indicate complete conformance of the traffic control device to the Manual on Uniform Traffic Control Devices.

8. Physical Condition Indices were calculated in the same manner as the Conformance Indices.

Analysis Methodology

Summaries, frequency distributions, and cross tabulations of questionnaire data reveal what traffic engineering functions are presently being performed and secondly, identification of who or what department is responsible for the administration of these traffic engineering functions

with respect to city and town size.

For further analysis, a series of statistical tests were used to make an evaluation of the effects (benefits and disbenefits) of the traffic engineering functions performed or not performed with respect to the type of traffic engineering administration and the city or town size. The statistical tests include one-way analysis of variance, two-way analysis of variance, and regression analysis. A description of each method is discussed in the following paragraphs.

One-way analysis of variance was used to test the hypothesis that the means of N groups of data points are all equal. The groups were formed according to the classification of the independent variable under consideration. For example, in this study, it was wanted to be determined whether there is any influence of city or town population size on the computed Conformance Index; the independent variable in this case is the city or town population range groupings while the dependent variable is the Conformance Index.

Two-way analysis of variance was used to test the hypothesis that the variance between the means of grouped data is due to two independent variables instead of the previous one independent variable. In the above example, the second independent variable upon which the grouping is based, could be the traffic engineering background

of the person in charge of the traffic engineering functions.

Because of the small number of cases upon which analysis is being performed in this study, analysis of variance beyond two-way classification becomes impactical. To overcome this difficulty, linear regression analysis was used to find the variables which indicated a statistically significant relationship when more than two variables were involved or when two-way analysis of variance was impossible because of too low a number of observations in some of the cells. For example, the dependent variable may be accidents and the independent variables may be population, sign Conformance Index, and the number of traffic engineering surveys and studies that have been conducted during the last year.

In the determination of what traffic engineering functions should be performed and who or what department should administer them with respect to the city or town size, consideration was given to all the summaries and analyses as discussed above. In addition, conversations with Indiana state officials and personal observations were also used in making the judgements.

CHAPTER III

SUMMARIES AND CROSSTABULATIONS OF SURVEY DATA

A total of thirty-one cities and towns were visited during the conduct of this study, from which data were collected on twenty-six of them. Of these twenty-six cities and towns, complete data was obtained from seventeen of them. Data on the remaining cities and towns varies from just the traffic control device survey data to complete data sets except for the accident data. When appropriate, the incomplete data sets were included in the summary data presented in this chapter. The summary data was also used in the analysis of accidents, accident rates, Conformance Indices and Physical Condition Indices.

Title of the Person in Charge of the Traffic Engineering Functions

The crosstabulation of the title of the person in charge of the traffic engineering functions by population range of the municipalities is shown in Table 2 for the cities and towns surveyed.

Table 2

Crosstabulation of the Titles of the Persons in Charge of
the Traffic Engineering Functions by Population Range

| Population Range | City or Town Engineer | Street Superintendent | Public Works Director | Traffic Engineer | Traffic Safety Officer | Town President or City Mayor | Group of Officials | Others | Row Total, Percent |
|-----------------------------|--------------------------|--------------------------|--------------------------|---------------------|---------------------------|---------------------------------|-----------------------|----------|--------------------------|
| 2,000 - 9,999 | 2 | 2 | 1 | 0 | 2 | 1 | 1 | 0 | 9 45.0 |
| 10,000 - 19,999 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 5 25.0 |
| 20,000 - 50,000 | 3 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 6 30.0 |
| Column Total, Percent | 7 35.0 | 2 10.0 | 1 5.0 | 2 10.0 | 5 25.0 | 1 5.0 | 1 5.0 | 1 5.0 | 20 100.0 |

The person in charge of the traffic engineering functions tended to be either the municipality's engineer or a designated police officer of the city or town. These two titles of the person in charge accounted for sixty percent of the cities and towns surveyed.

As the population of the cities and towns sampled decreased, the variation in the title designation was observed to increase. This is expected because the budget size of the small municipalities plus the small personnel staffs available, require that a person be assigned more than one duty to perform.

In most cases, the person to whom the duties of traffic engineering were assigned often had many other assignments to perform. This resulted in usually a lack of time to properly and completely perform the tasks required of traffic engineering. Traffic engineering usually was regarded as a minor duty in relation to their other duties. However, many of these people stated that they knew that more time should be devoted on traffic engineering, but that they had other duties to perform. This was especially true for the police officers and city engineers.

Traffic Engineering Background of the Persons in Charge of the Traffic Engineering Functions

In the questionnaire survey, the traffic engineering background was asked of those persons filling out the survey.

These classifications are as follows.

1. On the job experience only.
2. Attendance at conferences, seminars, or university courses.
3. University or college degree program.

The first classification, "on the job experience", accounted for fifty five percent of the persons answering the survey. Thirty five percent of the persons in charge had attended traffic engineering conferences, seminars, or university courses. Two of the persons in charge of the traffic engineering functions or ten percent, had received their traffic engineering background in university or college degree programs. Both of these persons are traffic engineering consultants and work with their associated cities through their consulting firms.

The crosstabulation of the traffic engineering background by population range is shown in Table 3. The table also shows the distribution of the traffic engineering backgrounds.

Table 3
Crosstabulation of Traffic Engineering
Background by Population Range

| Population Range | On the Job Experience | Conferences, Seminars, or University Courses | University or College Degree Programs | Row Total, Percent |
|-----------------------|-----------------------|--|---------------------------------------|--------------------|
| 2,000 - 9,999 | 8 | 1 | 0 | 9 45.0 |
| 10,000 - 19,999 | 1 | 3 | 1 | 5 25.0 |
| 20,000 - 50,000 | 2 | 3 | 1 | 6 30.0 |
| Column Total, Percent | 11 55.0 | 7 35.0 | 2 10.0 | 20 100.0 |

Percentage of Time Devoted to Traffic
Engineering by the Person in Charge

The respondents to the questionnaire were asked to state what percentage of their time was devoted to the administration of the traffic engineering functions in their city or town. In most instances, the person in charge stated that they did not know how much time was spent in carrying out their traffic engineering duties and therefore, could only give a very rough estimate.

Most of the responses ranged between five and thirty percent of the person's time devoted to traffic engineering.

A plot of percent of time devoted to traffic engineering by population of the city or town is presented in Figure 2 for the cities and towns sampled. It was observed that there was no significant relationship between the two variables.

It should be noted, though, that within the population range of 40,000 to 50,000 people, the percent of time devoted to traffic engineering is significantly larger than for other populations. Additional data points from more municipalities within the range of 20,000 to 50,000 persons might help to indicate some relationship between the variables.

Traffic Engineering Expenditures

Before any of the traffic engineering functions can be performed, the monetary funds to support these functions must be allocated from the city's or town's budget. The respondents were therefore asked to indicate the number of mandays and the dollar amount spent on the maintenance of signs, signals, and markings. Only seven of the cities and towns were able to furnish part of this information.

The expenditure for traffic engineering related activities ranged from \$0.86 to \$1.94 per capita. The collected data were plotted and a linear regression of dollars per capita by population was performed but did not reveal any clear relationships.

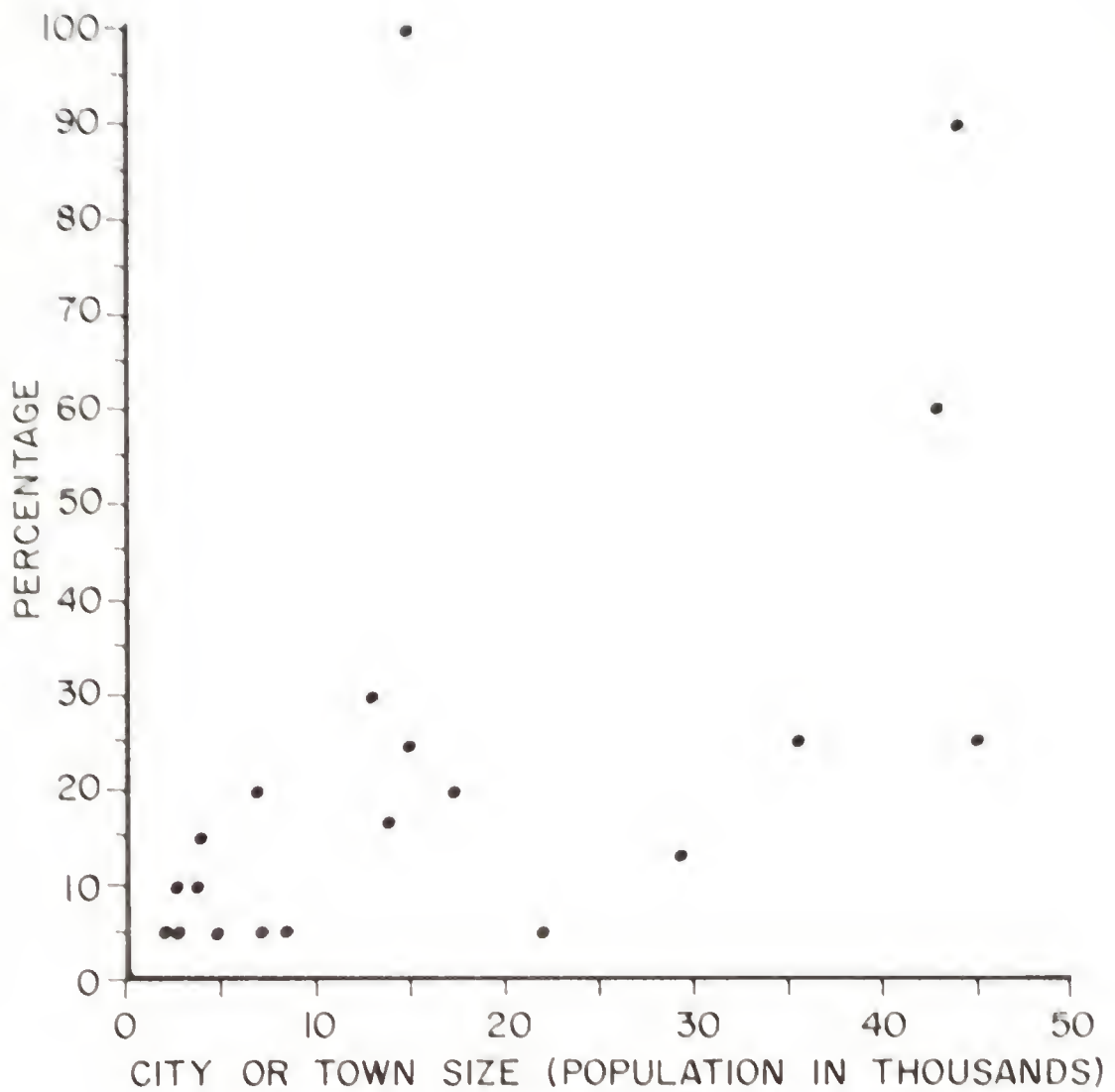


FIGURE 2. PERCENT OF TIME DEVOTED TO TRAFFIC ENGINEERING BY POPULATION OF CITY OR TOWN SAMPLED.

The amount of personnel time expended for traffic engineering related activities ranged from 0.022 to 0.111 mandays per capita. The collected data were plotted and a linear regression of mandays per capita by population was performed. This analysis did not reveal any clear relationship. This was probably due to the fact that there were only five data points from cities of comparable population size. Additional data points throughout the population range considered in this study may have revealed a significant relationship.

It was reported that additional financial assistance was received by four of the cities surveyed between the years 1970-1974 from grants funded through the Indiana Department of Traffic Safety and Vehicle Inspection. These grants were all for an inventory of traffic control devices and for high accident location studies.

The Number of Traffic Engineering Studies and Surveys Conducted

The cities and towns sampled were asked if any of the following five studies or surveys had been conducted in their city or town on a regular basis in the recent past.

1. Travel time and delay studies.
2. Spot speed studies.
3. Parking demand and supply studies.
4. Origin and destination studies.

5. High accident location studies.

As would be expected, the total number of studies and surveys conducted increases with increasing population. Of special note, though, is the fact that all of the cities and towns within the population range of 2,000 to 10,000 people, a total of nine cities and towns, conducted only a total of three studies or surveys.

Table 4 shows the crosstabulation of the number of studies or surveys performed by population range. A detailed breakdown of all of the traffic engineering functions performed and the person in charge of these functions is presented later in this chapter.

Table 4

Crosstabulation of the Number of Traffic Engineering Studies and Surveys Conducted by Population Range

| Population Range | Number of Traffic Engineering Studies and Surveys ^a | | | | | Row Total, Percent |
|-----------------------------|--|-----------|-----------|-----------|-----------|--------------------|
| | None 0 | One 1 | Two 2 | Four 4 | Five 5 | |
| 2,000 - 9,999 | 6 | 3 | 0 | 0 | 0 | 9 45.0 |
| 10,000 - 19,999 | 0 | 1 | 1 | 1 | 2 | 5 25.0 |
| 20,000 - 50,000 | 0 | 0 | 2 | 2 | 4 | 6 30.0 |
| Column Total, Percent | 6 30.0 | 4 20.0 | 5 15.0 | 1 5.0 | 6 30.0 | 20 100.0 |

a. None of the cities or towns surveyed conducted exactly three studies and surveys.

The Number of Traffic Engineering Inventories
Conducted

One section of the questionnaire survey asked which of the following five traffic engineering related inventories does the city or town currently have.

1. Inventory of traffic signals.
2. Inventory of traffic signs.
3. Inventory of pavement markings.
4. Inventory of traffic volumes.
5. Inventory of traffic accidents.

Much like the traffic engineering studies and surveys and as expected, the number of inventories conducted increases with the increasing population size of the community.

The crosstabulation of the number of inventories conducted by population range is shown in Table 5.

Table 5

Crosstabulation of the Number of Traffic Engineering Inventories Conducted by Population Range

| Population Range | Number of Traffic Engineering Inventories | | | | | | Row Total, Percent |
|-----------------------|---|-----------|----------|------------|-----------|-----------|--------------------|
| | None 0 | One 1 | Two 2 | Three 3 | Four 4 | Five 5 | |
| 2,000 - 9,999 | 1 | 4 | 1 | 2 | 1 | 0 | 9 45.0 |
| 10,000 - 19,999 | 0 | 0 | 0 | 2 | 0 | 3 | 5 25.0 |
| 20,000 - 50,000 | 0 | 0 | 0 | 1 | 2 | 3 | 6 30.0 |
| Column Total, Percent | 1 5.0 | 4 20.0 | 1 5.0 | 5 25.0 | 3 15.0 | 6 30.0 | 20 100.0 |

Responsibility for Performing the Individual
Traffic Engineering Functions

It was observed that the person designated in the completed questionnaire as in charge of the traffic engineering functions was not necessarily the person who

performed all of the traffic engineering functions. The person in charge may perform a majority of them, with the rest of the functions distributed among other officials and personnel of the city or town. It is generally hypothesized that the greater the concentration of traffic engineering functions under the administration of one person, the greater is the coordination in the performance of the traffic engineering activities. Accordingly, an effort was made to examine the effect of this concentration of the traffic engineering functions upon accidents, accident rates, Conformance Indices, and Physical Condition Indices. The result of this test is discussed in the next two chapters.

The distribution of the titles to whom a particular traffic engineering function, decision, or responsibility has been assigned is shown in Table 6 through Table 33 for each of the functions for all of the cities and towns sampled. Titles to which the function, decision, or responsibility may be assigned are listed below.

1. City or Town Engineer
2. Street Superintendent
3. City Council or Town Board
4. Consultant
5. Public Works Director
6. Public Utility
7. Traffic Commission

8. Traffic Engineer
9. Traffic Safety Officer or Police Officer
10. Town Board President or City Mayor
11. Group decision makers
12. Does not apply
13. Other
14. Not done

The tables also indicate how many cities and towns do not perform the particular traffic engineering function.

When appropriate, the relationship between population and whether or not the particular traffic engineering related function is performed, is presented schematically with the associated table.

Traffic Engineering Studies and Surveys

Traffic engineering studies and surveys provide the basic data base from which an effective solution can be formulated for most traffic problems.

Accordingly, the respondents to the questionnaire were asked whether or not some specific traffic engineering studies and surveys were conducted in their city or town and who is responsible for conducting the studies and surveys. The specific studies and surveys for which they were questioned about is as follows.

1. Travel time and delay studies
2. Spot speed studies

3. Parking demand and supply studies
4. Origin and destination studies
5. High accident location studies

Travel Time and Delay Studies. Due to the geographic size and lower traffic volumes in the smaller of the cities and towns surveyed, very little in regards to traffic engineering will reduce travel time and delay with the exception of the removal of some of the possibly unwarranted traffic control devices. In the larger of the cities surveyed, travel time and delay studies would provide valuable information as to where problems exist.

As can be seen in Table 6, twelve, or sixty percent of the cities and towns surveyed, did not conduct travel time and delay studies. The Table also shows that the responsibility of conducting the study is not assigned to any one particular title.

In Figure 3 is shown the relationship between population size and whether or not the travel time and delay studies are performed. The Figure shows that for the cities and towns surveyed, there does not exist a definite population size at which travel time studies are either performed or not performed. There existed an overlap approximately between the populations of 12,000 and 28,000 people. This overlap may be due to factors such as whether or not the city is rural or within a larger urban area, the land use pattern of the city, or

whether or not the person in charge of the traffic engineering functions believes that the study is necessary.

Table 6

Person Responsible for Travel Time and Delay Studies

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Consultant | 1 |
| Traffic Commission | 1 |
| Traffic Engineer | 2 |
| Traffic Safety Officer or Police Officer . . . | 2 |
| Other | 1 |
| Not done | 12 |
| Total | 20 |

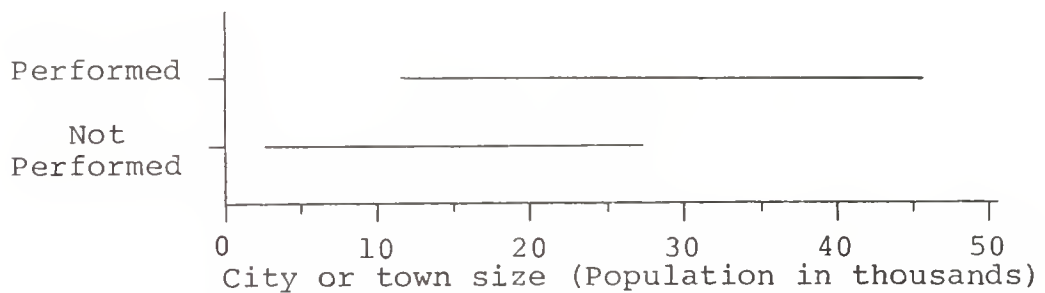


Figure 3. Relationship between city or town population and whether or not Travel Time and Delay Studies are performed.

Spot Speed Studies. In the smaller cities and towns, most of the main arterials are either state highways or streets located in the commercial area of the city or town. In the first case, the Indiana State Highway Commission does the study on the state highways or in the second case, spot speed studies are not normally necessary in the commercial area. Only when there are arterials other than state highways and not located in a congested commercial areas, may there be a need for spot speed studies. The number of arterials within a community are themselves usually a function of the city or town size and the land use pattern.

For the cities and towns surveyed, it can be seen in Table 7 that twelve or sixty percent of the municipalities did not conduct spot speed studies. In the other eight cities that did conduct the studies, the duty was assigned to four different titles. The title of "traffic engineer" was the most frequently cited as the person responsible for conducting the study.

Whether or not the study was performed and its relationship to the population size of the city or town is illustrated in Figure 4 for the cities and towns surveyed. The Figure shows that for populations up to approximately 12,000 persons, spot speed studies were not performed. For populations greater than approximately 21,000, the cities did conduct spot speed studies. An overlap occurred

between the populations of 12,000 and 21,000 people where spot speed studies were both performed and not performed; again, depending upon many possible factors.

Table 7
Person Responsible for Spot Speed Studies

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| Consultant | 1 |
| Traffic Engineer | 3 |
| Traffic Safety Officer or Police Officer . . . | 2 |
| Other | 2 |
| Not done | 12 |
| Total | 20 |

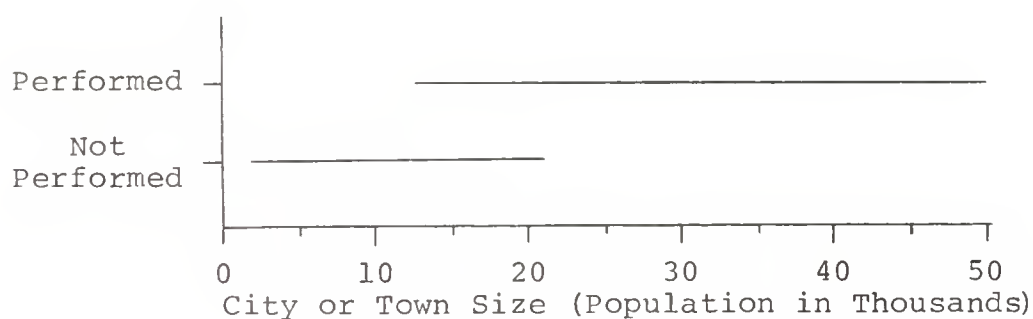


Figure 4. Relationship between city or town population and whether or not Spot Speed Studies are performed.

Parking Demand and Supply Studies. For a parking demand to exist, there must be an attraction to which the people of the city or town will want to travel. The size and the type of attraction, commonly a commercial area, is usually a function of the size of the city or town itself.

It was determined from the survey that eleven or fifty five percent of the cities or towns have not conducted parking demand and supply studies. This is shown in Table 8 for the cities and towns visited. Also shown are the titles of the persons in charge of the parking demand and supply studies.

The relationship between the population size of the city or town and whether or not parking supply and demand studies are performed can be seen in Figure 5 for the cities and towns from which data was obtained. The Figure shows a large overlap between the populations of approximately 12,000 to 29,000 people. This is probably due to the land use patterns of these particular cities.

Table 8

Person Responsible for Parking Demand and Supply Studies

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Consultant | 2 |
| Traffic Engineer | 2 |
| Traffic Safety Officer and Police Officer . . . | 3 |
| Other | 1 |
| Not done | 11 |
| Total | 20 |

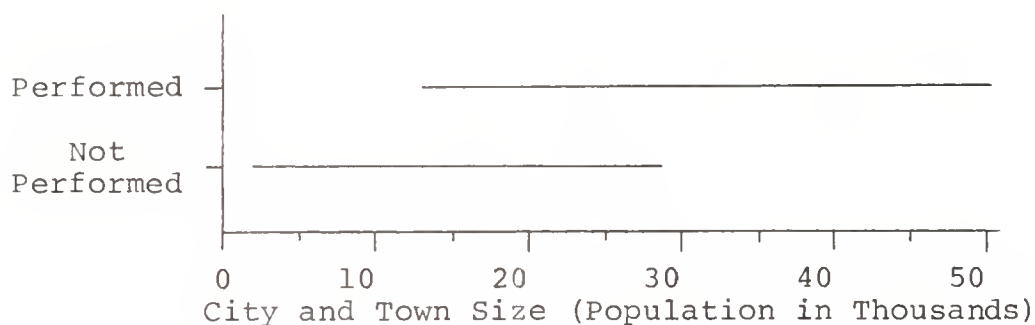


Figure 5. Relationship between population size and whether or not Parking Demand and Supply Studies are performed.

Origin and Destination Studies. Usually the only time in which an origin and destination study is conducted is when a city or town is of a fairly large size, located

within a metropolitan area, or located within a planning area. A few of the smaller cities visited during the conduct of this study did reside within a planning area, and therefore, have had origin and destination studies done in their community.

It is shown in Table 9 that only six or thirty percent of the cities and towns have actually had an origin or destination survey conducted within their municipality. The Table also shows who is responsible for carrying out the origin and destination survey.

As was stated earlier, population size of the city or town or surrounding area is a major determinate of whether or not an origin and destination study is performed. In Figure 6 is shown this relationship for the cities and towns surveyed. The large overlap is due to the fact that some of the smaller cities are a part of larger urban areas.

Table 9

Person Responsible for Origin and Destination Studies

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| Consultant | 1 |
| Traffic Engineer | 2 |
| Other | 3 |
| Not done | 14 |
| Total | 20 |

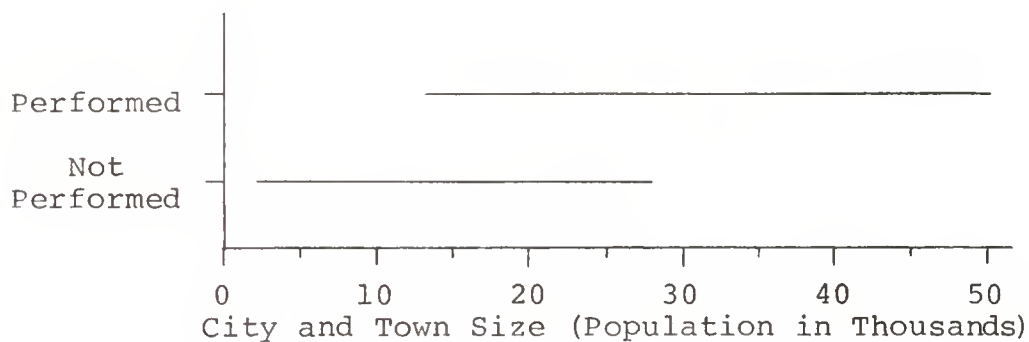


Figure 6. Relationship between population size and whether or not Origin and Destination Studies are performed.

High accident location studies are performed so as to determine if some type of traffic engineering improvement can be made in order to reduce the number of accidents or the severity of the accidents at different locations within a city or town. These high accident locations usually

occur at high traffic volume locations. Besides the number of accidents, the number of accidents per volume of traffic per day at an intersection is usually another good indicator for when a high accident location study is warranted.

The answers to the questionnaire revealed that only six or thirty percent of the cities and towns surveyed did not conduct any high accident location studies. Five of these cities or towns had a population of less than 4,000 persons. The title most frequently cited as the person responsible for conducting the studies was, as shown in Table 10, the "traffic safety officer" of the city or town.

Table 10

Person Responsible for High Accident Location Studies

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Consultant | 2 |
| Public Works Direction | 1 |
| Traffic Engineer | 4 |
| Traffic Safety Officer or Police Officer . . . | 6 |
| Not done | 6 |
| Total | 20 |

Curb Use Restrictions

Whenever the demand for curb space becomes greater than the supply, priorities must be established. This demand may require restrictions as to the use of the available curb space. The purpose of curb use restrictions may be to increase the load carrying capacity of the street, to increase parking space turnover rates in commercial areas, to provide loading zones for trucks, taxis, or buses, and to prohibit parking in areas where free movement of vehicles and emergency vehicles is necessary.

It is therefore the responsibility of the city or town, or the person so designated by the city or town, to apply the proper curb use restriction when and where warranted. The person making the decisions regarding curb use restrictions must know the effects of his decisions before they are implemented.

Shown in Tables 11, 12, 13, and 14 are the distributions of the titles of the person responsible for determining the need and location of different types of curb use restrictions.

All of the Tables show that the traffic safety officer or some other police officer is the most frequently cited title of the person responsible for the determination of the need and location of the four curb use restrictions of parking meters, truck loading zones, bus stops, or parking restrictions. The Tables also show a wide

diversification of titles to whom the decision making is assigned for other than the traffic safety officer.

Table 11

Person Responsible for the Determination of
the Need and Location of Parking Meters

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City Council or Town Board | 6 |
| Public Works Direction | 2 |
| Traffic Commission | 1 |
| Traffic Safety Officer and Police Officer . . . | 6 |
| Town Board President or City Mayor | 1 |
| Does not apply | 2 |
| Other | 2 |
| Total | 20 |

Table 12

Person Responsible for the Determination of
the Need and Location of Truck Loading Zones

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City Council or Town Board | 1 |
| Public Works Director | 1 |
| Traffic Commission | 1 |
| Traffic Engineer | 3 |
| Traffic Safety Officer or Police Officer . . . | 8 |
| Group decision makers | 1 |
| Does not apply | 4 |
| Not done | 1 |
| Total | 20 |

Table 13

Person Responsible for the Determination
of the Need and Location of Bus Stops

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City Council or Town Board | 1 |
| Public Works Director | 1 |
| Traffic Commission | 1 |
| Traffic Engineer | 3 |
| Traffic Safety Officer or Police Officer . . . | 2 |
| Does not apply | 12 |
| Total | 20 |

Table 14

Person Responsible for the Determination of the
Need and Location of Parking Restrictions

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| Street Superintendent | 1 |
| City Council or Town Board | 4 |
| Traffic Commission | 2 |
| Traffic Engineer | 3 |
| Traffic Safety Officer or Police Officer . . . | 9 |
| Group decision makers | 1 |
| Total | 20 |

Municipal Off-Street Parking

When parking demand is much greater than parking supply, one solution is to provide municipal off-street parking. Off-street parking promotes the attractiveness of commercial areas, relieves streets of traffic interference due to parking, and therefore decreases accidents that occur during parking maneuvers. The need for off-street parking is usually a function of traffic volume and land use pattern, which in turn is usually a function of city or town population size.

Because of the large expenses associated with the development of an off-street parking lot and the wants and requirements of the prospective users, careful consideration must be made of need and location of any proposed municipal off-street parking. The person determining the need and location must know what the effects will be upon the users and the surrounding area of any new off-street parking area.

In Table 15, is shown the distribution of the titles of the persons responsible for the determination of the need and location of municipal off-street parking facilities for the cities and towns sampled. The Table shows that the final decision maker is usually the governing body of the municipality.

Table 15

Person Responsible for the Determination of the Need
and Location of Municipal Off-street Parking

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 2 |
| City Council or Town Board | 8 |
| Public Works Director | 1 |
| Traffic Commission | 1 |
| Traffic Safety Officer or Police Officer . . . | 1 |
| Group decision makers | 4 |
| Does not apply | 3 |
| Total | 20 |

Signs, Signals and Markings

Traffic control devices are used to regulate, warn, and direct the motorist in his operation of his vehicle in order to transport his goods and himself efficiently and safely as possible. The motorist relies on the traffic control devices and the rules of the road so as to reach his destination safely.

The person responsible for determining the need and location of any type of traffic control device must therefore have the knowledge of how to convey the necessary messages to the motorist in the most effective

and responsive manner. Traffic control devices which do not fulfill a need, command attention, convey a clear simple meaning, command respect of the road user, and give an adequate time for response; are worthless in communicating messages. They may actually be a hazard to the driver and his surrounding environment.

In Tables 16, 17, 18, and 19 are shown the distributors of the titles of the persons responsible for determining the need and location of various traffic control devices for the cities and towns surveyed.

The Tables show that the title most frequently reported as the person responsible for determining the need and location of the various traffic control devices is the traffic safety officer or some other police officer of the cities and towns sampled. The Tables also show a wide diversification as to ~~whom~~ the responsibility is assigned for other than the traffic safety officer.

Table 16

Person Responsible for the Determination of the Need
and Location of Regulatory, Warning, and Direction Signs

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Street Superintendent | 2 |
| Consultant | 1 |
| Public Works Director | 2 |
| Traffic Commission | 4 |
| Traffic Engineer | 2 |
| Traffic Safety Officer or Police Officer . . . | 7 |
| Group decision makers | 1 |
| Total | 20 |

Table 17

Person Responsible for the Determination of the
Need and Location of Street Name Signs

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Street Superintendent | 4 |
| City Council or Town Board | 1 |
| Public Works Director | 2 |
| Traffic Commission | 2 |
| Traffic Engineer | 2 |
| Traffic Safety Officer or Police Officer . . . | 7 |
| Group decision makers | 1 |
| Total | 20 |

Table 18

Person Responsible for the Determination of the
Need and Location of Pavement Markings

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Street Superintendent | 3 |
| Consultant | 1 |
| Public Works Director | 2 |
| Traffic Commission | 4 |
| Traffic Engineer | 2 |
| Traffic Safety Officer or Police Officer . . . | 6 |
| Group decision makers | 1 |
| Total | 20 |

Table 19

Person Responsible for the Determination of
the Need and Location of Traffic Signals

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 2 |
| Street Superintendent | 1 |
| Consultant | 1 |
| Public Works Director | 2 |
| Traffic Commission | 3 |
| Traffic Engineer | 2 |
| Traffic Safety Officer or Policy Officer . . . | 5 |
| Group decision makers | 2 |
| Does not apply | 2 |
| Total | 20 |

For traffic control devices to continually be effective, they must be properly maintained. A traffic control device that is in poor physical condition may not fully serve the purpose for which it was intended; that is, the clear and quick conveyance of a message.

In Tables 20 and 21 is shown the distribution of the titles of the persons responsible for the maintenance of the traffic control devices in the cities and towns sampled.

The Tables show that the street superintendent or street department are most frequently cited as the person or department responsible for the maintenance of the traffic control devices in most of the cities and towns visited.

Table 20

Person Responsible for the Maintenance of
the Regulatory, Warning, Direction, and
Street Name Signs and Pavement Markings

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| Street Superintendent | 12 |
| Public Works Director | 3 |
| Traffic Engineer | 3 |
| Traffic Safety Officer or Police Officer . . . | 1 |
| Other | 1 |
| Total | 20 |

Table 21

Person Responsible for the Maintenance of the Traffic Signals

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| Street Superintendent | 7 |
| Public Works Director | 5 |
| Public utility | 1 |
| Traffic Engineer | 2 |
| Traffic Safety Officer and Police Officer . . . | 1 |
| Does not apply | 2 |
| Other | 2 |
| Total | 20 |

Channelization

Channelization is mainly used to separate and direct flows of traffic so as to either speed the movement of the vehicles, to prohibit some movements, or to provide refuge for turning vehicles. The need for channelization is mainly a function of traffic volumes and therefore of city and town population size.

The person who decides whether or not channelization is needed must know the principles of geometric design and what the effect of the channelization will be upon the motorists reactions.

The distribution of the titles of the person responsible for the determination of the need and location of channelization is shown in Table 22 for the cities and towns surveyed. The Table shows a wide diversification of the titles of the person to whom responsibility is assigned for the decision of whether or not channelization is needed and its design.

Table 22

Person Responsibility for the Determination of
the Need and Location of Channelization

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 2 |
| Street Superintendent | 2 |
| Consultant | 1 |
| Public Works Director | 2 |
| Traffic Commission | 3 |
| Traffic Engineer | 2 |
| Traffic Safety Officer or Police Officer . . . | 3 |
| Group decision makers | 1 |
| Other | 1 |
| Not done | 3 |
| Total | 20 |

Turning Restrictions

The utilization of proper turn controls can accomplish the following objectives: (1) elimination or reduction of intersection conflicts involving vehicle versus vehicle or pedestrian interactions, (2) reduction of accident hazards, (3) reduction of delay, and (4) increased intersection capacity. Since the rerouting of vehicles prohibited from turning at a particular intersection may sometimes create problems at other intersections; it is necessary that the person making the decision is aware of the possible secondary effects of the implementation of the turning restriction.

In Table 23 is shown the distribution of the titles of the person responsible for the determination of the need and location of turning restrictions for the city and towns surveyed.

The Table shows that the traffic safety office or some other police officer is the most frequently cited title of the person responsible for the determination of the need and location of turning restrictions.

Table 23

Person Responsibility for the Determination of the
Need and Location of Turning Restrictions

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| Street Superintendent | 2 |
| Consultant | 1 |
| Public Work Director | 3 |
| Traffic Commission | 4 |
| Traffic Engineer | 3 |
| Traffic Safety Officer or Police Officer . . . | 7 |
| Total | 20 |

School Route Protection

Traffic control in school areas is a highly sensitive subject. An overuse of school crossing controls, can tend to lessen the respect for the controls. Safe and effective traffic control can best be obtained through application of traffic control devices only at locations at which the volume and speed of traffic, street width, and the number of children crossing warrant their use. The decision to use a particular device for school route protection at a particular location should be made on the basis of an engineering study by persons who know what the effect will be of installation of the traffic control devices.

The distribution of the titles of the persons responsible for the determination of the need and the location for school route protection is shown in Table 24 for the cities and towns sampled.

The Table shows that the responsibility for school route protection is usually assigned to either the traffic commission, traffic engineer, or traffic safety officer. These three titles accounted for sixty percent of the responses for the cities and towns surveyed.

Table 24

Person Responsibility for the Determination of the
Need and Location for School Route Protection

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Street Superintendent | 2 |
| Consultant | 1 |
| Public Works Director | 2 |
| Traffic Commission | 4 |
| Traffic Engineer | 3 |
| Traffic Safety Officer or Police Officer . . . | 5 |
| Group decision makers | 2 |
| Total | 20 |

Miscellaneous Traffic Engineering Functions

Curb Openings for driveway entrances or exits onto high volume streets or near intersections can produce a location at which the probability of vehicle conflicts with pedestrians or other vehicles is raised substantially. It is therefore necessary that careful consideration be given to any proposed location of driveway entrances or exits because of the possibility of conflicting vehicular movements.

The distribution of the titles of the persons responsible for granting curb cuts is shown in Table 25 for the cities and towns surveyed. The Table shows that the city or town engineer is the most often cited title of the person responsible for permitting curb cuts.

Table 25
Person Responsible for Granting Curb Cuts

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 8 |
| Street Superintendent | 2 |
| City Council or Town Board | 3 |
| Public Works Director | 3 |
| Traffic Safety Officer or Police Officer . . . | 1 |
| Town Board President or City Mayor | 1 |
| Group decision makers | 1 |
| Not done | 1 |
| Total | 20 |

Parades and Special Events require the rerouting of traffic around the parade or the rerouting of traffic to, from, and around the special events. The rerouting of traffic must be well coordinated so as to minimize the confusion and delay to the motorist and to move the vehicles efficiently as possible. This requires that the person responsible for the control of the traffic movements knows how to coordinate the traffic flows over the available road network.

The distribution of the titles of the person responsible for the coordination of traffic for parades and special

events is shown in Table 26 for the cities and towns sampled. The Table shows that the traffic safety officer or some other police officer was designated as the person responsible for the coordination of traffic for parades and special events for seventy five percent of the cities and towns surveyed.

Table 26

Person Responsible for Coordination of
Traffic For Parades and Special Events

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| Public Works Director | 2 |
| Traffic Commission | 1 |
| Traffic Engineer | 2 |
| Traffic Safety Officer or Police Officer . . . | 15 |
| Total | 20 |

Street Lighting should be provided for locations where illumination is a recognized necessity for greater traffic safety and roadway visibility. Street lighting involves a capital investment and a continuing maintenance and operational expense and therefore, should not be used when unwarranted.

In Table 27 is the distribution of the titles of the person responsible for the determination of the need and

location of street lighting in the cities and towns surveyed.

Table 27 shows that the governing body of the municipality or the board of public works determines the need and location of street lighting for seventy five percent of the cities and towns responding.

As shown in Table 28, a public service company maintains the street lighting in sixty five percent of the cities and towns sampled and the public works department maintains the street lighting in thirty percent of the cities and towns surveyed.

Table 27

Person Responsibility for the Determination of
the Need and Location of Street Lighting

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| City Council or Town Board | 7 |
| Consultant | 1 |
| Public Works Director | 8 |
| Town Board President or City Mayor | 2 |
| Other | 1 |
| Total | 20 |

Table 28

Person Responsible for the Maintenance of the Street Lighting

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| Street Superintendent | 1 |
| Public Works Director | 6 |
| Public Utility | 13 |
| Total | 20 |

Geometric Design is related to the capabilities and limitations of the motorist, his vehicle, and the roadway. Traffic volumes and speeds are major factors to be considered in the geometric design of the roadway in order to provide for safe, efficient and economic traffic operations.

In the smaller cities and towns, geometric design considerations are not as great a necessity; but as population increases, so do traffic volumes and the resulting need for good geometric design of the roadways.

The person designing or checking the geometric design of a roadway section must be knowledgeable in this field of engineering. If not, the design of the roadway or intersection may slow the flow of traffic and may increase the number of conflicting movements and the probability of an accident occurring.

The tabulation of the data in Table 29 shows that the person responsible for the geometric design or the checking of the geometric design of the roadway is most commonly the city or town engineer. Fifty five percent of the cities and towns surveyed responded with this answer. Twenty percent of the cities or towns had no one to check the geometric design of the roadways.

Table 29

Person Responsible for Geometric Design

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 11 |
| Street Superintendent | 3 |
| Consultant | 1 |
| Group decision makers | 1 |
| Not done | 4 |
| Total | 20 |

Traffic Engineering Inventories

Without the basic information, it is difficult to systematically solve any traffic engineering problem or to establish any programmed maintenance schedule. In the present study an effort was made to examine the type of personnel used to perform the various traffic engineering

inventories in a city or town.

In the following paragraphs the titles to whom the updating of major traffic engineering inventories are assigned to are discussed.

Traffic Signal Inventories include the geometric dimensions of the intersection, the location of all of the signal heads, the configuration of the signal faces, the size and type of equipment and the signal timing. All of this data, plus other inventory data, is used in an intersection analysis for determining signal timing and phasing and other measures needed to reduce delay and accidents.

Accurate traffic signal inventories and maintenance records enables a program of scheduled maintenance to be established such that the likelihood of a system failure is greatly reduced, thereby increasing traffic safety. The person responsible for updating these inventories must keep accurate and complete data on the traffic signal systems.

Because of the small size of the cities and towns studied and the fact that the Indiana State Highway Commission controls and maintains all traffic control devices located on state highways, the number of traffic signals under local control is small. There were in fact, six city and towns that did not have any traffic signals under local control.

In Table 30 is shown the distribution of the titles of the person responsible for the updating of the traffic signal inventory. The table shows that the responsibility of updating the traffic signal inventory is not assigned to any one particular title. The title of traffic safety officer had the highest occurrence to whom the responsibility was assigned.

Table 30

Person Responsible for the Updating
of the Traffic Signal Inventories

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Consultant | 2 |
| Public Works Director | 1 |
| Traffic Engineer | 3 |
| Traffic Safety Officer or Police Officer . . . | 4 |
| Not done | 3 |
| Total | 14 |

Sign Inventories should consist of the sign type, material, location, condition, and conformance of the sign to the Manual on Uniform Traffic Control Devices. All of this information is needed for programming the

number of signs that need to be replaced each year. A sign that does not conform to the standards or is in poor physical condition is not as effective in conveying messages to the motorist as a sign in good condition and in conformance to the standards. An inventory of signs also informs the city or town of whether or not their signs conform to Indiana State Statutes and therefore indicate their possible legal liabilities.

A distribution of the titles of the persons responsible for the updating of the sign inventory is shown in Table 38 for the cities and towns surveyed.

As shown in Table 31, only one city or town did not have a sign inventory. The Table does not show, though, how complete or up to date the sign inventories are for the cities and towns sampled. In some cases, the inventory consisted of only the type and location of sign. The Table also shows that the street superintendent or street department was most frequently cited as the person or department responsible for the updating of the traffic sign inventory for thirty percent of the cities and towns sampled.

Table 31

Person Responsible for the Updating of the Sign Inventory

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Street Superintendent | 6 |
| Consultant | 2 |
| Traffic Engineer | 4 |
| Traffic Safety Officer or Police Officer . . . | 3 |
| Town Board President or City Mayor | 1 |
| Other | 2 |
| Not done | 1 |
| Total | 20 |

Traffic Volume Inventories consists of volume counts on the arterials of the cities and towns. Volume counts are needed to properly time traffic signals, and for determining what type of traffic control device may be needed at a particular intersection. The warrants for the different types of traffic control devices are usually based on volume counts. Therefore, an accurate and current traffic volume inventory is a basic tool in traffic engineering.

In Table 32 is shown the distribution of the titles of the person responsible for the updating of the traffic volume inventory for the cities and towns sampled.

The Table shows that ten or fifty percent of the cities and towns sampled do not have an inventory of traffic volumes on the arterial streets of the municipalities.

In Figure 7 is shown the relationship between population size and whether or not the traffic volume inventory exists. The Figure reveals that all of the cities and towns surveyed with less than 10,000 people do not have an inventory of traffic volumes.

Table 32

Person Responsible for the Updating
of the Traffic Volume Inventory

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| City or Town Engineer | 1 |
| Consultant | 1 |
| Traffic Engineer | 4 |
| Traffic Safety Officer or Police Officer . . . | 3 |
| Other | 1 |
| Not done | 10 |
| Total | 20 |

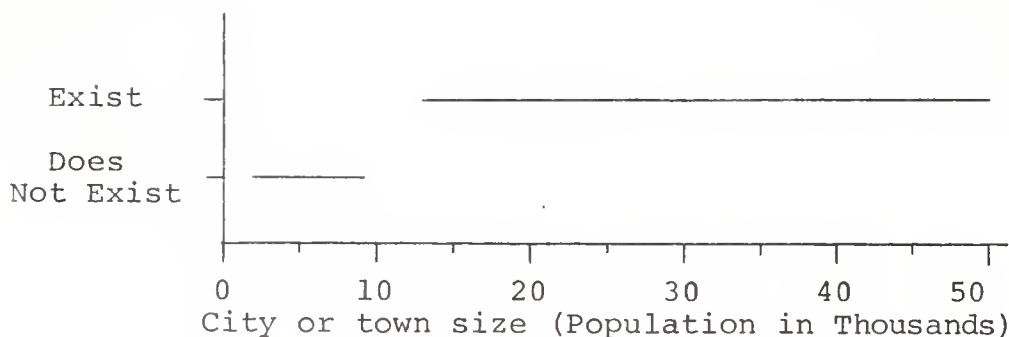


Figure 7. Relationship between population and whether or not a Traffic Volume Inventory exists.

Traffic Accident Inventories. There are many reasons for keeping a traffic accident inventory. It furnishes complete and quick information about accidents at any location. It reveals the most hazardous intersections and detailed accident facts about each. It is an important aid in constructing collision diagrams. It aids in the preparation of selective law enforcement programs.

Accident records should be either filed by location or a cross reference system be established so that accidents occurring at a particular location can easily be found. In this way, high accident locations can easily be determined.

In Table 33 is shown the distribution of the titles of the persons responsible for the updating of the traffic accident inventory if one exists. As shown in the Table, five of the twenty cities surveyed do not keep an accident

inventory of any kind. They just file the accident records by chronological order.

The Table also shows that in fifty percent of the cities and towns surveyed, the traffic safety officer has the responsibility for updating the traffic accident inventories.

In Figure 8 is shown the relationship between population size and whether or not a traffic accident inventory is kept. The Figure shows that the traffic accident inventories do not exist in only a few of the smaller cities and towns.

Table 33

Person Responsible for the Updating
of the Traffic Accident Inventories

| Title of the Person Responsible for the Performance of the Traffic Engineering Function | Absolute Frequency |
|---|--------------------|
| Consultant | 1 |
| Traffic Engineer | 3 |
| Traffic Safety Officer or Police Officer . . . | 10 |
| Other | 1 |
| Not done | 5 |
| Total | 20 |

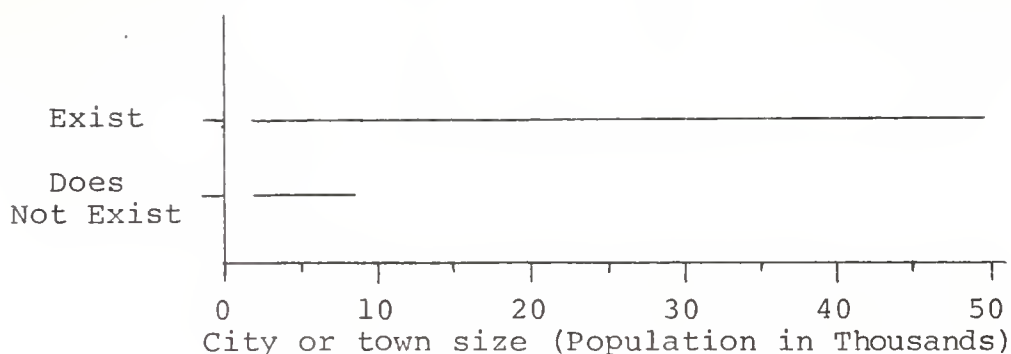


Figure 8. Relationship between population and whether or not a Traffic Accident Inventory exists.

Traffic Engineering Reference Books

The correct solution to a traffic engineering problem comes about only if the person in charge of the traffic engineering functions possesses the knowledge and tools necessary to analyze the problem. If the knowledge and tools are not possessed by the person in charge, then they must be easily available to him.

Two questions in the survey asked whether the person in charge of the traffic engineering functions or his department had a copy of the 1965 Traffic Engineering Handbook, published by the Institute of Traffic Engineers or the Manual on Uniform Traffic Control Devices, published by the U.S. Department of Transportation, Federal Highway Administration.

Thirty percent of the cities and towns responding, did not have either of the reference sources. Seventy percent of the cities and towns did have a copy of the

Manual on Uniform Traffic Control Devices. Half of these seventy percent also had the Traffic Engineering Handbook. Generally, as the population size of the city or town increased, the probability of the city or town possessing one or both of these traffic engineering reference sources increased.

The crosstabulation of reference books by population range is shown in Table 34 for the cities and towns surveyed.

Table 34

Crosstabulation of Traffic Engineering
Reference Books by Population Range

| Population Range | No Books | Manual on Uniform Traffic Control Devices | Manual on Uniform Traffic Control Devices and Traffic Engineering Handbook | Row Total, Percent |
|-----------------------|-----------|---|--|--------------------|
| 2,000 - 9,999 | 5 | 4 | 0 | 9 45.0 |
| 10,000 - 19,999 | 0 | 1 | 4 | 5 25.0 |
| 20,000 - 50,000 | 1 | 2 | 3 | 6 30.0 |
| Column Total, Percent | 6 30.0 | 7 35.0 | 7 35.0 | 20 100.0 |

Traffic Problems

In an effort to determine what specific traffic problems are of concern to the communities, the respondents were asked to evaluate the following traffic problems as they relate to their city or town.

- A. Inadequate parking in commercial area.
- B. High accident locations.
- C. School crossings.
- D. Traffic congestion.
- E. Traffic in residential neighborhoods.
- F. Pedestrian-Auto conflict.

The following rating scheme was used in the subjective self evaluation of the traffic problems that were of concern to the community.

- 1. Little or no concern
- 2.
- 3. Some concern
- 4.
- 5. Great concern

In Table 35, each of the traffic problems has been ranked according to their respective mean responses for these cities and towns sampled. It can be seen that parking, accidents, and congestion are considered to be traffic problems of some concern, much like the larger metropolitan areas.

Table 35

Traffic Problems of Concern to the Municipalities

| Traffic Problem | Mean Response |
|--|------------------|
| Inadequate parking in commercial areas . | 3.750 |
| High accident locations | 3.150 |
| Traffic congestion | 3.000 |
| School crossings | 2.750 |
| Bicycle-Auto conflicts | 2.250 |
| Traffic in residential neighborhoods . . | 2.150 |
| Pedestrian-Auto conflicts | 1.900 |

Traffic Engineering Needs

An effort was made to estimate what the local municipalities consider to be the most critical needs in the area of traffic engineering. Accordingly, the person in charge of the traffic engineering functions was asked to indicate their need for each of the five given items, respective to the municipalities need for traffic engineering. The following rating scheme was used to indicate their need.

1. Little or no need
2. Some need
3. Great need

The summary of the responses to this question is presented in Table 36 for the cities and towns surveyed.

It can be noted that according to the respondents, there is some need for materials, equipment, information, and personnel. All of these, except information, need fairly large continuing financial support. Information, though, is a low cost initial and continuing investment, but is a necessity for the efficient use of the other items.

Table 36
Traffic Engineering Needs Rating

| Traffic Engineering Need | Mean Response |
|---------------------------------------|------------------|
| Additional materials | 2.200 |
| Additional equipment | 2.000 |
| Additional geometric improvements . . | 1.950 |
| Additional technical information . . | 1.850 |
| Additional personnel | 1.700 |

The Understanding of the Need for Traffic Engineering
Services by the Municipality's Governing Body

Like any other municipal service, the traffic engineering personnel also need the support of the governing body of the city or town in order to provide adequately the traffic engineering services needed. To have this

support, the governing body must understand what the needs of the city or town are in regards to traffic engineering. They must know what traffic engineering is and how it can benefit their community.

The respondents were therefore asked to judge the understanding of their city's or town's governing body with regards to the needs for traffic engineering services. The rating scheme used was as follows.

1. No understanding
2. Slight grasp
3. Adequate understanding
4. Knows it well

In Table 37 is shown the frequency distribution of the rating of the governing body's understanding of the municipality's need for traffic engineering services. A mean value of 2.8 was computed for the responses. These ratings were later compared to the computed Conformance Indices and Physical Condition Indices for traffic control devices and with the number of traffic accidents reported.

In addition, a plot and a linear regression analysis of the understanding rating by population was conducted. However, no significant relationship between the two variables was observed to exist.

Table 37

Governing Body's Understanding
of Municipality's Need for
Traffic Engineering Services

| Rating of Understanding | Absolute Frequency |
|------------------------------|-----------------------|
| 1 No understanding | 1 |
| 2 Slight grasp | 9 |
| 3 Adequate understanding . . | 6 |
| 4 Knows it well | 4 |

Rating of the Quality of Traffic
Engineering Within the Municipality

The respondents were asked to rate the quality of the traffic engineering services conducted in their city or town in regard to those areas within local jurisdiction.

The distribution of the ratings of the quality of the traffic engineering services is shown in Table 38. The mean response was found to be 3.2 for the cities and towns surveyed.

These ratings were also compared with the Conformance Indices and Physical Condition Indices and the number of accidents reported in the next two chapters.

A plot and a linear regression of the quality rating by population indicated that there was no significant relationship between the two variables.

Table 38

Quality Rating of the Municipality's
Traffic Engineering Services

| Quality Rating | Absolute Frequency |
|----------------|-----------------------|
| 1 Poor | 0 |
| 2 | 4 |
| 3 Adequate | 9 |
| 4 | 6 |
| 5 Excellent | 1 |

Ratings of the Coordination and Cooperation of
the Indiana State Highway Commission

Coordination and cooperation between the Indiana State Highway Commission and the cities and towns are essential in providing roadways for the safe, efficient and convenient movement of persons and goods on the state highways located within the boundaries of the local governments.

Because of the fact that the Indiana State Highway Commission has the responsibility to design, install, and maintain all of the traffic control devices on state highways located within the cities and towns of Indiana, the respondents to the questionnaire were asked to rate the coordination and cooperation between the city or town and the Indiana State Highway Commission. The rating of "1"

was assigned as the lowest rating and "10" was assigned as the highest rating.

In Table 39 is shown the distribution of the ratings of the coordination and cooperation of the Indiana State Highway Commission.

The mean response of 7.90 for the ratings indicates that, in general, there exists a high level of cooperation between the Indiana State Highway Commission and the small municipalities, in general. However, the personal interview revealed that the level of coordination and cooperation may not be uniform throughout the state, depending upon which highway district the city or town is located.

Table 39

Ratings of the Coordination and
Cooperation of the Indiana
State Highway Commission

| Rating | Absolute Frequency |
|-----------|-----------------------|
| 1 (low) | 1 |
| 2 | 1 |
| 3 | 0 |
| 4 | 0 |
| 5 | 1 |
| 6 | 0 |
| 7 | 2 |
| 8 | 6 |
| 9 | 2 |
| 10 (high) | 7 |

Effectiveness Ratings of the Traffic

Control Devices of the Indiana

State Highway Commission

The person in charge of the traffic engineering functions in his city or town is a fairly good judge of the effectiveness of any of the traffic control devices in the community because of his recurrent interaction with them throughout the year. The respondents were, therefore, asked to rate the effectiveness of the state controlled traffic control devices (that are located on the streets within their municipality). A value of "1" was assigned as the lowest rating and a value of "10" was assigned as the highest rating.

The distribution of the ratings on the effectiveness of the traffic control devices under control of the Indiana State Highway Commission is shown in Table 40. The average rating of 8.05 indicates again, that in general, the small municipalities consider that the Indiana State Highway Commission is performing its responsibilities well.

However, one of the towns gave a rating of "1" for both effectiveness of the traffic controls and for the coordination and cooperation of the Indiana State Highway Commission. Through onsite investigation, it was observed that two intersections on a state highway within the boundary of this municipality had highly inadequate traffic signals.

It was therefore assumed that the local adverse response was primarily based on the poor quality of the traffic signal system at these intersections. These traffic signals were approximately fifteen years old and have not been updated to meet the standards of the Manual on Uniform Traffic Control Devices.

Table 40

Effectiveness Ratings
of the Traffic Control
Devices of the Indiana
State Highway Commission

| Ratings | Absolute Frequency |
|---------|-----------------------|
| 1 | 1 |
| 2 | 0 |
| 3 | 0 |
| 4 | 0 |
| 5 | 2 |
| 6 | 0 |
| 7 | 1 |
| 8 | 6 |
| 9 | 5 |
| 10 | 5 |

Suggested Forms of Traffic Engineering

Assistance from Different Government Institutions

The respondents were asked how the present government institutions could aid their city or town in performing the traffic engineering functions. The government institutions for which the respondents were asked to comment on are listed below.

- 1 City Council or Town Board
- 2 County Government
- 3 Indiana State Highway Commission
- 4 Federal Highway Administration
- 5 Purdue University School of Civil Engineering,
Joint Highway Research Project

In general, the comments indicated a want and need for more traffic engineering technical information. The respondents expressed the desire for the continuation of the annual traffic engineering conference held at Purdue University and the need for additional technical information from the Indiana State Highway Commission and Purdue University. Two other recurring comments were those expressing a need for financial aid and help in applying for the financial aid.

In Appendix B are the comments made by the respondents, sorted by the source of suggested aid.

CHAPTER IV

TRAFFIC CONTROL DEVICE CONFORMANCE AND PHYSICAL CONDITION ANALYSIS

Traffic control devices are the media upon which the motorist depends for the information needed for safe driving. These devices inform the motorist of the regulations in effect at a particular location, warn him of areas in which caution is needed, and direct him to his desired destination.

Since traffic control devices play such an important role as a message medium, they must be understandable and easily visible to all of the drivers. The Manual on Uniform Traffic Control Devices specifies the shape, size, color, design, wording, and mounting locations of the traffic control devices in order that the motorist can quickly comprehend the meaning of each device and respond to it.

Due to this importance of traffic control devices in conveying messages to the vehicle operator, it is the responsibility of a municipality to properly erect and maintain the traffic control devices under its jurisdiction, according to the standards set forth in the Manual on Uniform Traffic Control Devices. In this study, it was

decided that a measurement of the conformance of the traffic control devices to the standards and a measurement of the physical condition of the traffic control devices would be a good indicator of how the small cities and towns of Indiana are performing their traffic engineering duties.

Traffic Control Devices and the Nonconformances

Found

Traffic Signs

During the conduct of this study, a total of 1,036 traffic signs located at intersections of local streets, were inspected so as to determine their conformance to the Manual on Uniform Traffic Control Devices. In Table 41 are shown the traffic sign nonconformances, ranked according to the number of times in which they occurred.

As shown in the table, the mounting of the traffic signs at a height of less than seven feet was the most recurrent nonconformance found for all of the signs inspected. Three other major nonconformances found were the nonreflectorization of the regulatory and warning signs, nonstandard color usage on a sign, and nonstandard secondary messages on the face of the signs.

Table 41

Traffic Signs and the Nonconformances Found

| Nonconformance | Absolute Frequency | Percentage of All Signs |
|--|--------------------|-------------------------|
| Mounted height less than seven feet | 745 | 71.9 |
| Nonreflectorized | 257 | 24.8 |
| Nonstandard color | 201 | 19.4 |
| Nonstandard secondary message on sign face | 193 | 18.6 |
| One Way Sign needed | 36 | 3.5 |
| Nonstandard location | 28 | 2.7 |
| Nonstandard application | 28 | 2.7 |
| Nonstandard shape | 22 | 2.1 |
| Traffic sign needed | 14 | 1.4 |
| Nonstandard design | 14 | 1.4 |
| Nonstandard size | 7 | 0.7 |

Traffic Signals

In the survey of traffic control devices, a total of 554 traffic signals located at intersections of local streets, were inspected so as to determine their conformance to the Manual on Uniform Traffic Control Devices. In Table 42 are shown the traffic signal nonconformances, ranked according to the number of times in which they occurred.

The Table shows that the most frequently found traffic signal nonconformance was that of a nonstandard shape or design of the pedestrian signals. The second most frequent nonconformance was the lack of a second signal face which is required for each approach to an intersection.

Table 42

Traffic Signals and the Nonconformances Found

| Nonconformancies | Absolute Frequency | Percentage of All Signals |
|---|--------------------|---------------------------|
| Nonstandard shape or design of pedestrian signals | 72 | 14.3 |
| Number of traffic signal faces needed | 64 | 12.7 |
| Nonstandard traffic signal system operation | 28 | 5.5 |
| Nonstandard lens design | 8 | 1.6 |

Pavement Markings

In the cities and towns surveyed, a total of 1,067 pavement markings were inspected so as to determine their conformance to the Manual on Uniform Traffic Control Devices. In Table 43 are shown the pavement marking nonconformances, ranked according to the number of times in which they occurred.

The Table shows that for pavement markings, there are only two nonconformances which were frequently found. The first major nonconformance was usage of undersized, four inch wide crosswalk lines. Nonstandard color application was the second major nonconformance found. The color yellow was found to have been used for crosswalk lines, stop lines, and for single, solid centerlines.

Table 43

Pavement Markings and the Nonconformances Found

| Nonconformances | Absolute Frequency | Percentage of All Pavement Markings |
|---|--------------------|-------------------------------------|
| Nonstandard, 4 inch wide crosswalk markings | 377 | 35.3 |
| Nonstandard color application . . | 175 | 16.4 |
| Nonstandard size | 4 | 0.3 |
| Missing pavement marking that is required | 4 | 0.3 |
| Nonstandard design | 1 | 0.0 |

Traffic Control Device Conformance Indices
and Their Relationship to City or Town Population Size

Small cities and towns have limited staffs and budgets, and therefore, the amount of time usually spent on traffic engineering is minimal. This fact is reflected in the

analysis of the relationship between the population of the city and town and the conformance of the traffic control devices.

It should be noted that in the analyses of the traffic control device conformance, the data from one city was not included because this particular city was considered to be an exception. The city employed a consulting engineer on a part time basis. During the traffic control device survey in this city, no sign could be found that had a nonconformance, that is, their Conformance Index for traffic signs was zero. The traffic signals and pavement markings also had a very low Conformance Index.

No other city in any population range with comparable Conformance Indices was found. The inclusion of the data from this city in the analysis would have significantly changed the average Conformance Indices for all cities in this population range because of the small sample and would not have provided values representative of all other cities studied.

Traffic Sign Conformance Indices

A oneway analyses of variance was performed on the computer Conformance Indices for the traffic signs inspected using the previously defined population range

as the independent variable for classification. In Table 44 is shown the analysis of variance table for traffic sign Conformance Indices by population range. The associated group statistics are shown in Table 45 for the cities and towns surveyed.

The analysis of variance table in Table 44 indicates that there is a statistically significant difference between the traffic sign conformance indices of the population group means. The significance level was found to be 0.022 for this one-way classification. Table 45 shows that the population group mean of the traffic sign Conformance Index decreases as the population size increases. The Table also shows that the within group variance may also decrease as the population size increases.

In Figure 9 is shown a plot of the traffic sign Conformance Indices by the population of the cities and towns. The plot also shows the relationship of the decreasing Conformance Index as the population size increases.

Table 44

Oneway Analysis of Variance
Traffic Sign Conformance Indices by Population Range

| Source | D.F. | Sum of Squares | Mean Squares | F Ratio | F Prob. |
|----------------|------|----------------|--------------|---------|---------|
| Between Groups | 2 | 1.3425 | 0.6712 | 4.545 | 0.022 |
| Within Groups | 22 | 3.2490 | 0.1477 | | |
| Total | 24 | 4.5914 | .. | .. | .. |

Table 45
Traffic Sign Conformance Index Group Statistics

| Population Range | Count | Mean | Variance | Standard Deviation | Standard Error | Minimum | Maximum |
|------------------|-------|--------|----------|--------------------|----------------|---------|---------|
| 2,000 - 1,999 | 12 | 1.6640 | 0.1886 | 0.4343 | 0.1254 | 0.8793 | 2.2778 |
| 10,000 - 19,999 | 6 | 1.3499 | 0.1226 | 0.3502 | 0.1429 | 0.9130 | 1.7619 |
| 20,000 - 50,000 | 7 | 1.1256 | 0.0936 | 0.3059 | 0.1156 | 0.7143 | 1.5479 |
| Total | 20 | 1.4379 | 0.1913 | 0.4374 | 0.0875 | 0.7143 | 2.2778 |

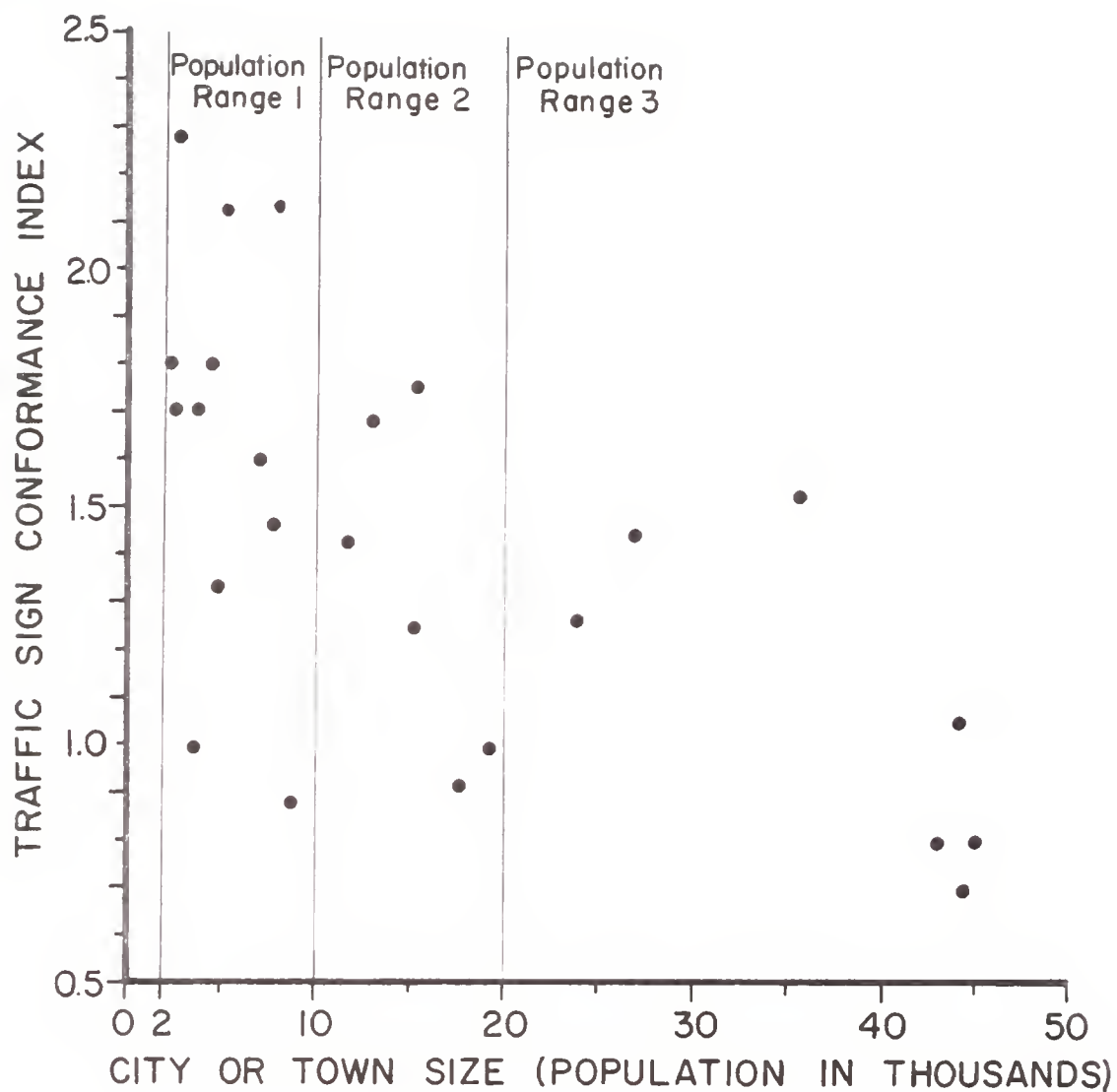


FIGURE 9. RELATIONSHIP BETWEEN TRAFFIC SIGN CONFORMANCE INDICES AND CITY OR TOWN POPULATION SIZE.

Traffic Signal Conformance

A one-way analysis of variance was performed on the Conformance Indices for the traffic signals surveyed using population ranges as the independent variable for classification. The analysis indicated no significant differences between the population group means for the cities and towns surveyed. The lack of a relationship is probably due to the fact that traffic signals are generally well maintained because of the physical and public prominence and because of their importance at the intersections of streets at which they are located.

Pavement Marking Conformance

An attempt was made to perform an one-way analysis of variance on the Conformance Indices for the pavement markings surveyed, using population ranges as the independent variable for classification. Due to the nonhomogeneous within group variances, different transformations of the data were attempted in order to make the groups homogeneous. However, no transformation could be found to satisfy this condition. More data points in the 20,000 to 50,000 population range would probably make the analysis possible. Linear regression analysis was therefore used in an attempt to show that a relationship existed.

Linear regression analysis indicated that a relationship between the pavement marking Conformance Indices and

the square root of the population of the city or town may exist. The significance level, with only the square root of the population entered into the equation, was 0.006 for the cities and towns surveyed.

In Table 46 are shown the group statistics for the Conformance Indices of pavement markings grouped by population ranges. The Table does show a decrease in the Conformance Index for pavement markings as the population size increases.

In Figure 10 is a plot of the pavement marking Conformance Indices by city or town population size. The plot shows that a relationship between the variables probably exists; that is, the pavement marking Conformance Index decreases as the population size increases.

Table 46
Pavement Marking Conformance Index Group Statistics

| Population Range | Count | Mean | Variance | Standard Deviation | Standard Error | Minimum | Maximum |
|------------------|-------|--------|----------|--------------------|----------------|---------|---------|
| 2,000 - 9,999 | 12 | 0.6811 | 0.3125 | 0.5590 | 0.1614 | 0.0000 | 2.0000 |
| 10,000 - 19,999 | 6 | 0.5634 | 0.3174 | 0.5827 | 0.2379 | 0.0000 | 1.4908 |
| 20,000 - 50,000 | 7 | 0.3132 | 0.0209 | 0.1446 | 0.0547 | 0.0625 | 0.5000 |
| Total | 20 | 0.5499 | 0.2441 | 0.4941 | 0.0988 | 0.0000 | 2.0000 |

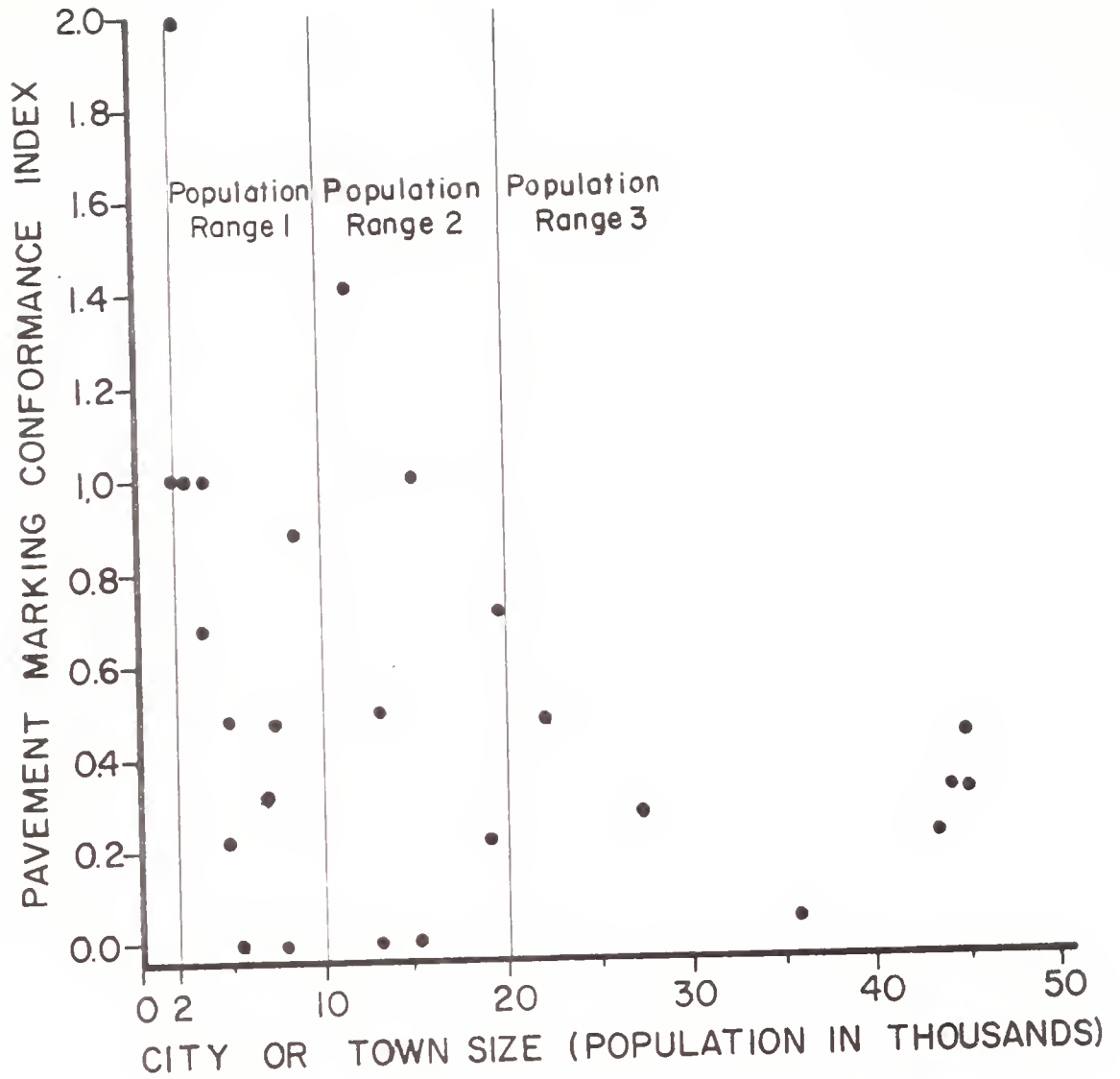


FIGURE 10. RELATIONSHIP BETWEEN PAVEMENT MARKING CONFORMANCE INDICES AND CITY OR TOWN SIZE.

Traffic Control Device Physical Condition
Indices and Their Relationship to City and Town
Population Size

One of the many factors that influence the effectiveness of any type of traffic control device is its physical condition. A traffic control device that is in poor physical condition may not satisfactorily serve its intended purpose and therefore may cause considerable confusion for the motorists. The traffic control device may therefore be more of a hazard than an aid to the vehicle operator when it is in a state of poor physical condition.

Traffic Sign Physical Condition

In the cities and towns surveyed, a total of 1,036 traffic signs were inspected so as to determine if the physical condition of the signs warranted any maintenance or replacement. It was observed that about 9.7 percent of the traffic signs inspected required maintenance or replacement.

One-way analysis of variance of the Physical Condition Indices by population range groups was not possible due to the fact that no transformation could be found so as to meet the requirement that the groups be of a homogenous variance.

In Table 47 are shown the group statistics of the Physical Condition Indices. The Table shows that the

Table 47

Traffic Sign Physical Condition Index Group Statistics

| Population Range | Count | Mean | Variance | Standard Deviation | Standard Error | Minimum | Maximum |
|------------------|-------|--------|----------|--------------------|----------------|---------|---------|
| 2,000 - 9,999 | 12 | 0.1818 | 0.0486 | 0.2205 | 0.0637 | 0 | 0.6000 |
| 10,000 - 19,999 | 6 | 0.1157 | 0.0379 | 0.1946 | 0.0794 | 0 | 0.5000 |
| 20,000 - 50,000 | 7 | 0.0356 | 0.0027 | 0.0524 | 0.0198 | 0 | 0.1370 |
| Total | 20 | 0.1251 | 0.0348 | 0.1866 | 0.0373 | 0 | 0.6000 |

Physical Condition Indices rapidly decrease as the population of the cities and towns increase.

The graph shown in Figure 11 also indicates that a relationship between the Physical Condition Indices and the city and town population size may exist; that is, the traffic sign Physical Condition Indices and the variance of the indices decrease as the population increases.

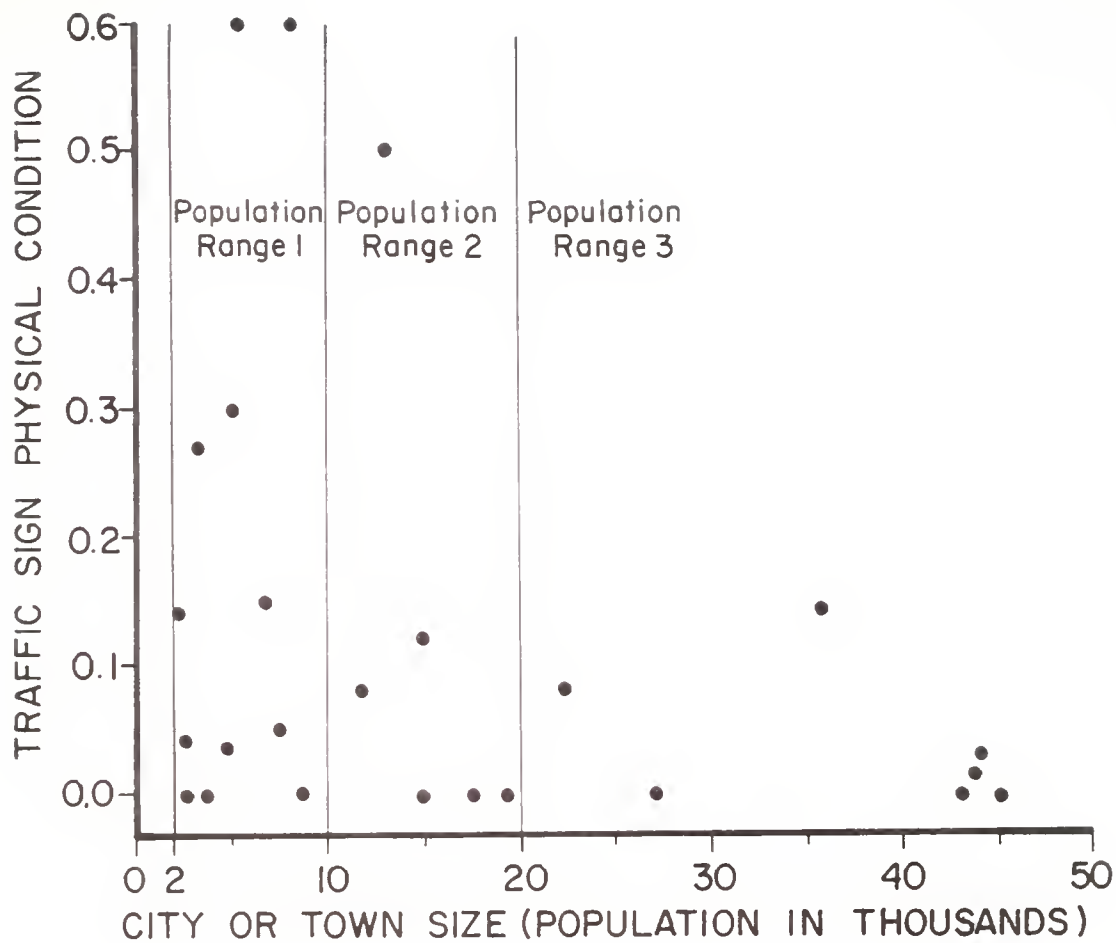


FIGURE II. RELATIONSHIP BETWEEN TRAFFIC SIGN PHYSICAL CONDITION INDICES AND CITY OR TOWN SIZE.

Traffic Signal Physical Condition

Due to the fact that traffic signals are usually located at comparatively high volume intersections and are therefore very important in controlling traffic, the traffic signals are therefore usually well maintained by the cities and towns.

One-way analysis of variance indicated that no differences existed between the group means of the computed traffic signal Physical Condition Indices. A plot of the Physical Condition Indices by population also showed no relationship. In fact, there were only two municipalities in which the traffic signals showed any lack of maintenance.

Pavement Marking Physical Condition

Pavement markings, much like traffic signals, are usually well maintained because of their obvious importance in guiding and separating traffic. In the smaller cities and towns surveyed, many of them had few or no pavement markings at the intersections. This is due to the fact that most of the streets have low traffic volumes and therefore, pavement markings are not as great a necessity as in the larger cities and towns.

Due to the fact that pavement markings are usually well maintained and that the smaller cities and towns have a comparatively fewer pavement markings, one-way analysis of variance tests and a plot of pavement marking Physical

Condition Indices by population showed no relationship between the variables.

Traffic Control Device Conformance Indices
and Their Relationship to Other Variables

Two-way analysis of variance, linear regression, and plots were used in an attempt to find other relationships that may exist between the traffic control device Conformance Indices and other variables as determined from the questionnaire. A significance level of 0.10 was used in the statistical analysis as the determining factor of whether or not a possible relationship may exist. The analyses, however, revealed only a few relationships that may actually exist. This may be due to the manner in which the indices were developed or the relationships that may actually exist are complicated interactions of the variables considered.

Traffic Sign and Signal Conformance

Possibly due to small sample size, no significant statistical relationship could be developed to relate the traffic sign Conformance Index with other factors. The traffic signal Conformance Index was also observed not to have any significant relationships with other factors. This is probably due to the fact that most traffic signals within a small city or town are under control of the Indiana

State Highway Commission with the result of very few traffic signals on local streets.

Pavement Marking Conformance Indices

A one-way analysis of variance was applied to determine whether or not the possession of a copy of the Manual on Uniform Traffic Control Devices has any effect upon the pavement marking Conformance Index. The computed significance levels and examination of the cell means, variances, and counts indicated that a relationship may exist. Due to the fact that two of the six cells had very few observations, a linear regression analysis was used to determine if a relationship does actually exist. It was observed that both the square root of the population and whether or not the person in charge of the traffic engineering functions possessed a copy of the Manual on Uniform Traffic Control Devices may have a significant effect upon the pavement marking Conformance Indices. The significance levels for these two factors were 0.072 and 0.074 respectively with an associated R^2 value of 0.485 for the cities and towns surveyed. Through these statistical tests, it can be concluded that if the person in charge of the traffic engineering functions has ready access to the Manual on Uniform Traffic Control Devices, then the pavement markings in the municipality tend to deviate less from the standards.

Illustrations of Nonstandard Traffic Signs
and Traffic Signs in Poor Condition

There are four main reasons for having standard, well maintained traffic signs within a municipality. Standard, well maintained traffic signs command attention; convey a clear, simple meaning; command respect of road users; and give adequate time for the proper response by the motorist.

Signs that are in poor condition may not attract the driver's attention or give adequate response time due to poor legibility. Also, nonconforming signs may not be completely understandable to the motorist due to the unfamiliarity of the traffic sign. Traffic signs that are in poor physical condition or nonstandard may therefore be actually hazardous to the motorist as well as to the surrounding vehicles, pedestrians, and private property.

Shown in Figures 12 through Figure 39, are some examples of traffic signs that were observed during the conduct of this study which were either in very poor condition, nonstandard, or both.

In Figures 12 and 13 are examples of signs whose surface condition requires the replacement of the signs. The traffic signs in Figures 14 and 15 are probably illegible at night due to the lack of contrasting colors of the very rusted and discolored signs. The only contrasting colors on the sign in Figure 16 are the dark rust spots on the



Figure 12. STOP sign with white on red painted over black on yellow.



Figure 13. A repainted STOP sign in very poor condition.



Figure 14. STOP sign in poor condition.



Figure 15. SPEED LIMIT sign in poor condition.



Figure 16. Paint worn off of lettering on rusting SPEED LIMIT sign.



Figure 17. White background paint has peeled off of a SPEED LIMIT sign uncovering an old, upside down SPEED LIMIT sign.



Figure 18. Badly damaged ONE WAY sign on which the black and white colors have been reversed.



Figure 19. A nonreflectORIZED STOP sign with a nonstandard secondary message on sign face.

white background of the sign as the paint on the legend has completely worn off.

The traffic sign in Figure 17 is a good illustration of wasted maintenance time and money. An old SPEED LIMIT sign was turned upside-down, repainted white, and then reflectorized lettering applied. The white background has peeled off revealing the legend of the old sign. It probably would have been cheaper to install a new sign that would have lasted and been effective for many years.

Badly damaged signs are difficult to read and understand. The ONE WAY sign in Figure 18 also has faded lettering and a nonstandard reversal of the colors.

To be effective, traffic signs should convey only one clear message. Secondary messages on the sign face can detract from the main message and sometimes can confuse the motorist as to the intended message. The STOP signs in Figures 19 and 20 illustrates secondary messages that can be confusing and distracting. It may be noted that the sign in Figure 20 is in excellent condition, but a reflectorized sign would be more visible at night than the nonreflectorized sign shown.

In Figures 21 through 23 are shown traffic signs which have colors that are not standard in accordance with their defined usage. The STOP sign in Figure 21 has black lettering on a yellow background. Yellow, as defined by the Manual on Uniform Traffic Control Devices,

" . . . is used as a background color for warning signs"
A STOP sign is not a warning sign.

The signs in Figures 22 and 23 are both white on green. Green is used as a background color only for guide signs and as a legend color for permissive parking regulations. The message on the sign of Figure 22 is a regulatory message prohibiting entrance. The sign is of the wrong shape, color, and word message. The background of the sign in Figure 23 should be yellow, for warning, with a black border and legend.

Signs that have small surface areas can easily be unseen by the passing motorists. The STOP and YIELD signs in Figures 24 and 25 are undersized and are of the wrong color.

Traffic signs with nonuniform shapes cannot be easily understood when the driver is at a distance too far to read the word message. In Figure 26 is a YIELD sign whose shape is similar to that of a FOREST ROUTE MARKER. The correct shape for the parking sign in Figure 27 would have been a vertical rectangle.

The traffic signs in Figures 28 through 31 are examples of signs located or mounted in a nonstandard manner. Signs improperly mounted or located may not be seen or may be misunderstood as to their meaning or to where the regulation is applied. The NO U TURN symbol sign in Figure 28 is mounted upside-down. The NO PASSING ZONE



Figure 21. Nonstandard black on yellow STOP sign with rust spots.



Figure 22. Nonstandard, white on green
DO NOT ENTER sign.



Figure 23. Nonstandard, white on green ROAD NARROWS sign.



Figure 24. Undersized, 18 inches by 18 inches, black on yellow STOP sign.



Figure 25. Undersized, 18 inches by 18 inches by 18 inches, black on yellow YIELD sign.



Figure 26. Nonstandard shape, black on yellow YIELD sign.



Figure 27. Nonstandard shape, horizontal rectangle, white on green PARKING sign.

warning sign in Figure 29 is mounted on the wrong side of the road. The SPEED LIMIT sign in Figure 30 is mounted only seventeen inches above the ground. The double STOP signs in Figure 31 are not allowed according to the Manual of Uniform Traffic Control Devices.

Traffic signs that are not of a standard design can be dangerously confusing or totally useless and sometimes even too distracting. In Figures 32 through 40 are shown signs of a nonstandard design.

The traffic signs in Figure 32 can be very confusing to the motorists. The signs are located at midblock where three faded yellow crosswalks are located next to a high school. An overhead, red flashing beacon is activated only when the crosswalks are being used in the morning, noon, and afternoon for the students coming to or going from the school. The top sign is black on white while the bottom sign is black on yellow. During the personal interview, the person in charge of the traffic engineering functions of this particular city stated that vehicles must stop only when the beacon is flashing. Most drivers would be confused as to what was required of them when approaching this area. These traffic control devices may cause more confusion than the intended understanding of the traffic control devices.

The nonstandard warning signs in Figures 36 and 37 are actually hazardous because their uniqueness distracts



Figure 28. Upside down NO U TURN symbol sign with an overlapping supplemental word message sign.



Figure 29. NO PASSING ZONE sign mounted on wrong side of roadway and fastened in a vandalism susceptible manner.



Figure 30. SPEED LIMIT sign mounted only 17 inches above ground level.



Figure 31. Nonstandard mounting of two STOP signs.



Figure 32. Nonstandard signs located at a midblock school crosswalk. Top sign is black on white and bottom sign is black on yellow.



Figure 33. Nonstandard, black on white sign located at a "T" intersection.



Figure 34. Nonstandard design of a ONE WAY sign.



Figure 35. Nonstandard design, white on red, DEAD END sign.

the drivers' attention for a longer period of time than it is necessary to convey the main message.

The nonstandard direction marker in Figure 38 is understandable only by the local people in the community. A stranger to the community would not know that this was a route marker to Indiana State Highway 43.

In Figure 39 is shown a supplemental sign that is in conflict with the state motor vehicle code. Parking is not allowed at corners or in front of fire hydrants.

The traffic signs that have been mentioned here are examples of poor administration of traffic engineering in a municipality. These signs are of little benefit to the public because they fail to properly inform the motorist of what is required of him in his operation of a vehicle. In addition, many of these signs in poor condition were actually eyesores and detract from the image of the municipality.



Figure 36. Nonstandard design, shape, message, and color, white on red, warning sign.



Figure 37. Nonstandard design, shape, and message on a warning sign with local business advertisement.



Figure 38. Nonstandard design, black on white, direction marker for Indiana State Highway 43.



Figure 39. Supplemental message in conflict with state motor vehicle code in regards to parking at corners and parking near fire hydrants.

CHAPTER V

ACCIDENT ANALYSIS

An attempt was made to estimate whether or not any benefit in traffic safety is derived from the performance of different traffic engineering functions in a city or town. Accordingly, various analyses were conducted in order to determine if relationships between traffic accidents and other traffic engineering variables existed.

The accident data used was the number of traffic accidents that occurred at intersections of local streets for the seventeen cities and towns from which complete data could be obtained.

The first traffic engineering variable considered was the number of intersections of local streets located within a city or town. A linear regression of accidents by the number of intersections produced a R^2 value of 0.779 with a significance level of 0.00001 for the cities and towns sampled. The relationship can be seen in Figure 40 with a plot of the number of accidents by the number of intersections of local streets for the cities and towns surveyed. As expected, the Figure shows that as the number of intersections increases, the number of traffic accidents also increase.

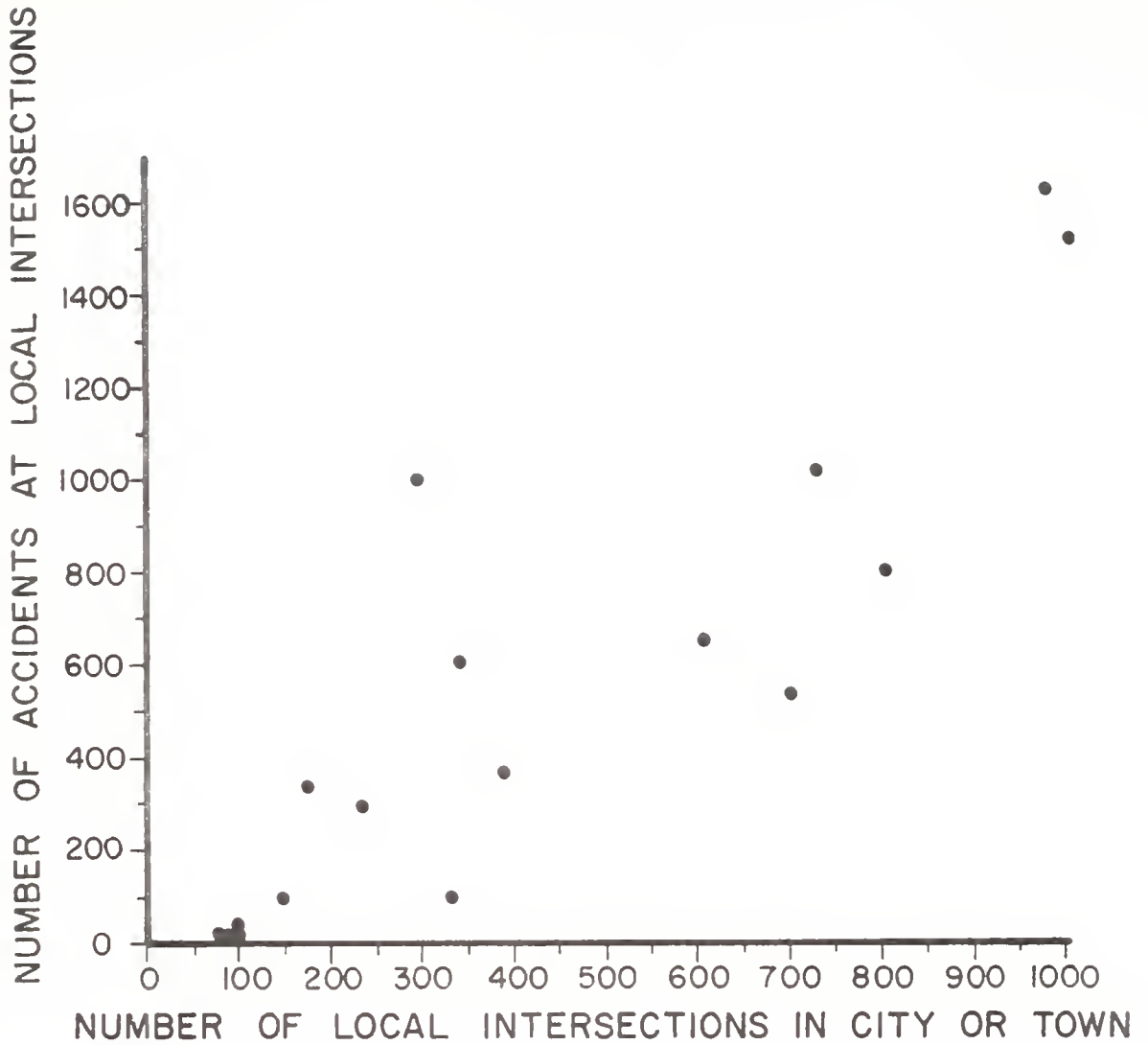


FIGURE 40. RELATIONSHIP BETWEEN THE NUMBER OF ACCIDENTS AND THE NUMBER OF INTERSECTIONS OF LOCAL STREETS.

Another variable that showed a relationship with the number of intersection accidents is the population of the city or town. It should be noted that population and the number of intersections of local streets are themselves, naturally correlated; a value of 0.962 was calculated as the correlation coefficient between these two variables.

In Figure 41 is shown the relationship between the number of accidents and the population of the city or town. As the population of the municipality increases, the number of traffic accidents also increases, as expected. A linear regression of the number of accidents by the population of the city or town produced on R^2 value of 0.740 with a significance level of 0.00001 for the cities and towns sampled.

Traffic signals are generally used at comparatively high volume intersections where the probability of an accident occurring is usually greater than at nonsignalized intersections. It is therefore expected that a city or town with traffic signals will have more accidents than a city or town of equal population size with fewer traffic signals. Furthermore, it was observed that the number of traffic signals in a municipality is highly correlated to the population size; a correlation coefficient of 0.765 was computed for these two variables.

In Figure 42 is shown the relationship between the number of accidents at intersections of local streets by

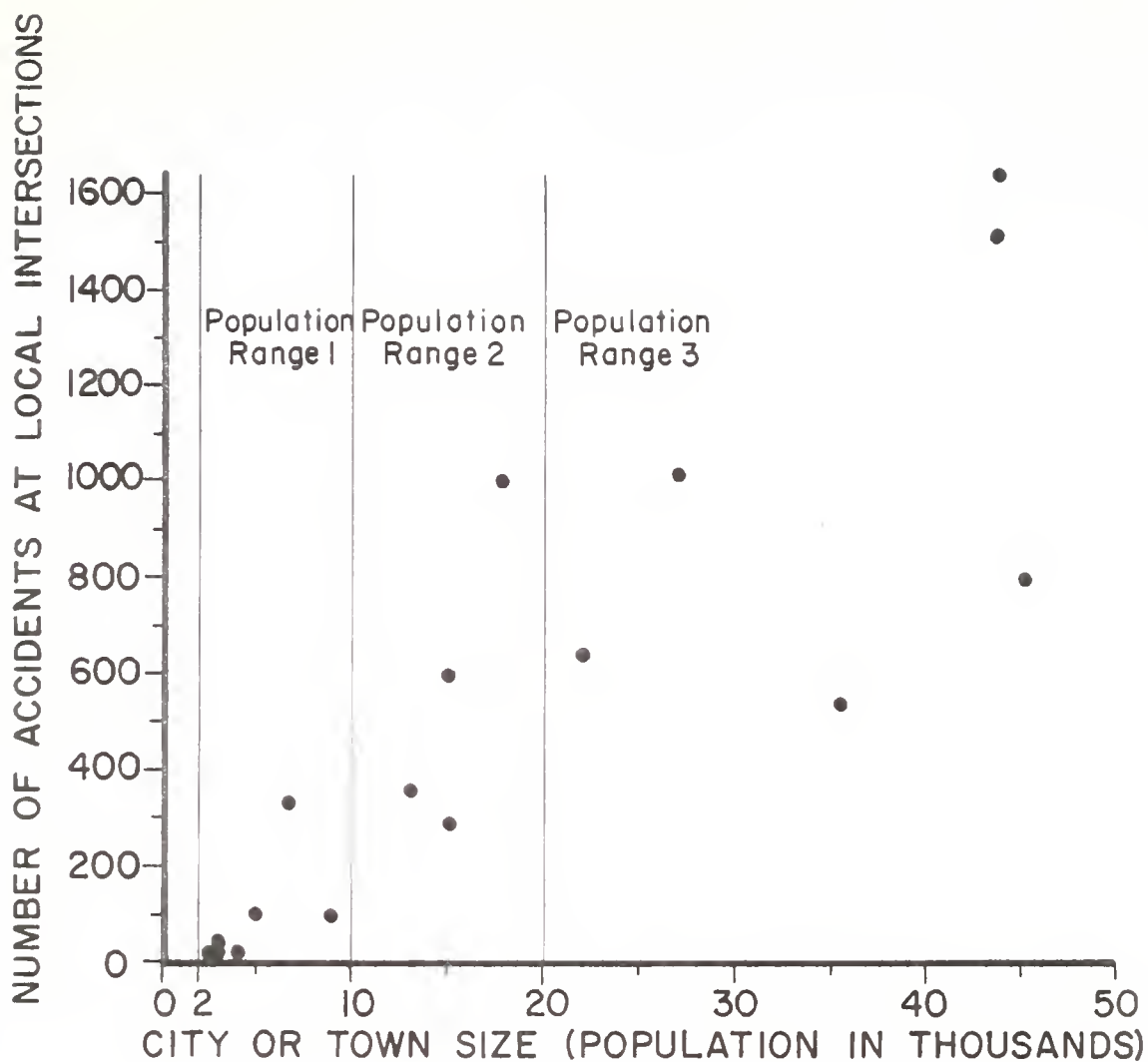


FIGURE 41. RELATIONSHIP BETWEEN THE NUMBER OF ACCIDENTS AND THE POPULATION OF THE CITY OR TOWN.

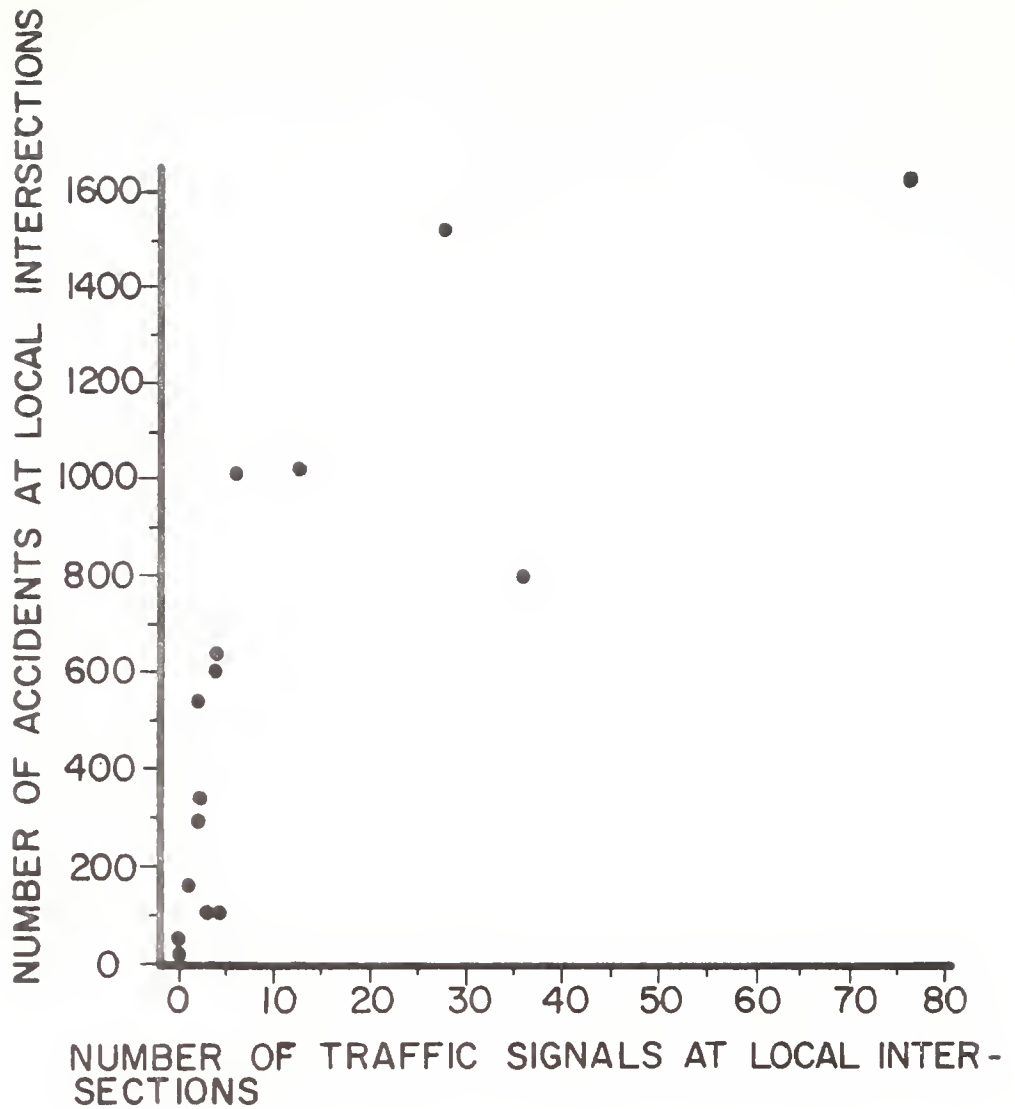


FIGURE 42. RELATIONSHIPS BETWEEN THE NUMBER OF ACCIDENTS AND THE NUMBER OF TRAFFIC SIGNALS AT INTERSECTIONS OF LOCAL STREETS.

the number of traffic signals located on local streets. A linear regression of the number of accidents at intersections of local streets by the number of traffic signals produced a R^2 value of 0.619 with a level of significance of 0.00009 for the cities and towns surveyed. The relationship found was that as the number of traffic signals increases, there is a corresponding increase in the number of traffic accidents.

One other variable also seemed to have a relationship with the number of traffic accidents occurring at intersections of local streets. This variable, the sign Conformance Index, was found to be highly correlated with the number of accidents but with the opposite sign than than expected; that is as the traffic sign Conformance Index increased the number of accidents decreased. This was because both the number of accidents and the sign Conformance Index are highly correlated with population size. After removal of the effect due to population, traffic sign conformance showed no statistical relationship to the number of traffic accidents.

A stepwise linear regression was then performed so as to determine those variables which may have the most significant effect upon traffic accidents. All variables as considered in this study were available to be entered into the equation if the variable showed to be significant. A significance value of 0.10 was used to determine if a

variable should be entered or removed from the equation. The resulting regression equation and the associated statistics are shown in Table 48. The R^2 value for this regression equation was computed to be 0.841 for the cities and towns surveyed. The regression analysis was used only to show significant relationships and not to develop a prediction equation.

Table 48

Traffic Accident Stepwise Regression Analysis

| Analysis of Variance | D.F. | Sum of Squares | Mean Squares | F Value | F Prob. |
|---------------------------|------|----------------|--------------|---------|---------|
| Regression | 3 | 3524446. | 1208149. | 22.97 | 0.000 |
| Residual | 13 | 683652 | 52589. | | |
| Variables in the Equation | | | Coefficients | F Value | F Prob. |
| Population | | | 18.32 | 9.64 | 0.008 |
| Signal Conformance Index | | | 320.92 | 5.04 | 0.043 |
| Number of Traffic Signals | | | 8.34 | 3.57 | 0.081 |
| Constant | | | 33.09 | 0.12 | 0.732 |

The regression analysis resulted in the following statistically significant relationship. The number of accidents increase as population size, the number of traffic signals, and the traffic signal Conformance Index of the municipalities increases.

It should be pointed out that the regression analysis indicates only those variables which are statistically most significant. It is likely that there could be other significant variables, besides those three included in the regression equation shown in Table 48, which were not identified or measured in the present study.

In addition to the analysis considering the total number of traffic accidents at intersections of local streets, a similar set of computations was conducted with accident rates as the dependent variable. The accident rate, as defined in this study, is the number of accidents occurring at intersections of local streets per 1,000 people for the cities and towns surveyed. However, no clear relationships could be observed between accident rates and any of the other variables included in this study.

Further analysis was conducted to determine if any other significant relationships existed between any of the variables as determined by this study. The analysis indicated that no other significantly important relationships were found.

CHAPTER VI
RECOMMENDATIONS REGARDING SMALL AREA TRAFFIC
ENGINEERING FUNCTIONS

The data summaries and the analyses performed indicate that a greater statewide effort should be made to increase the quality and quantity of the traffic engineering functions performed in the smaller cities and towns. The study showed that in general, as the population size of the city or town decreases, the quality and quantity of the traffic engineering functions performed also declined. This result was particularly evident in the analyses of the traffic sign and pavement marking Conformance Indices as well as in the computations involving the traffic sign Physical Condition Index.

The poor level of performance of the traffic engineering functions in the small urban areas can be attributed to several factors. Although its significance could not be established statistically, the lack of any traffic engineering educational background of the person in charge of the traffic engineering functions is probably one of the main reasons in most of the cases. It has been shown in Table 3 that the probability of the person in charge of the traffic engineering functions having no traffic engineering

educational background increases with decreasing population size. For the population range 2,000 to 9,999, only one of the nine cities and towns sampled had a person in charge of the traffic engineering functions who had any traffic engineering background, and that background was acquired through traffic engineering seminars or university courses. Many of the people in charge of the traffic engineering functions also stated that their knowledge in the area of traffic engineering was inadequate.

Another possible reason for the poor performance of the traffic engineering functions in small urban areas is monetary in nature. Like other municipal services, traffic engineering functions need continuous monetary funding in order to have an effect upon the community. But, the monetary sources of the smaller cities and towns, in most cases, are not large enough to fully support the traffic engineering functions and the other essential municipal services at the same time. A clear indication of this situation could be obtained in some of the cities and towns visited by simply observing the traffic signs. It was obvious that very little or nothing was spent even on the maintenance or replacement of very deteriorated signs. If the money is not available to maintain the traffic signs, it is probable that monetary funds are not available for the other traffic engineering functions. However, it should be recognized that the performance of certain traffic engineering functions might not be necessary for many of the small urban areas.

Recommendations for the Improvement of Traffic
Engineering in Small Urban Areas

The most important item needed to execute any of the traffic engineering functions is knowledge. The person in charge of the traffic engineering functions must know what his city or town requires in terms of traffic engineering services and either know how to perform or administer these services or know where this information can be obtained.

A possible vehicle for the transfer of this information is the annual traffic engineering conference held at Purdue University. An effort should be made to contact and encourage the people in charge of the traffic engineering functions in all of the small cities and towns to attend this conference. This is especially important for those cities and towns with the smaller populations.

Knowing where to find traffic engineering information was one of the problems that was expressed by the persons in charge of the traffic engineering functions. This problem can be easily remedied by having a list of reference books and publisher's addresses compiled by the Indiana State Highway Commission or the Indiana Department of Traffic Safety and Vehicle Inspection and made available to the cities and towns. The Indiana State Highway Commission and the Indiana Department of Traffic Safety and Vehicle Inspection might also expand efforts to provide

general traffic engineering information to any city or town that needs assistance but does not know where to find it.

Indiana State Statutes state that all local traffic control devices shall conform to the state manual and specifications. Therefore, every city and town should have a copy of the current Indiana Manual on Uniform Traffic Control Devices for Streets and Highways. It was observed that a few of the people in charge of the traffic engineering function did not know that a Federal or State manual even existed. It is therefore recommended that a copy of the Indiana Manual on Uniform Traffic Control Devices for Streets and Highways continue to be distributed to every city and town, without cost, and that additional copies be readily available at cost to the cities and towns.

There is also two other reference sources, which should be obtained by the cities and towns. The Model Traffic Ordinance³ is a specific set of guidelines for motor vehicle ordinances for a municipality which is consistent with the provisions of the state laws as embodied in the Uniform Vehicle Code.⁴ Its provisions are designed as a guide for municipalities to follow. Because the traffic operations in the municipalities are governed by the laws of the state, the person in charge of the traffic engineering functions should be familiar with the Indiana Motor Vehicle Laws. Therefore a copy of both the Model Traffic Ordinance and the Indiana Motor Vehicle Laws should also be similarly

obtained by the cities and towns.

A possible explanation of why the quality and quantity of the traffic engineering functions decreases as the population size of the municipalities decrease is that the governing bodies of these cities and towns are not familiar enough with the state laws in regards to traffic engineering and local traffic control devices. It is therefore essential that the public officials have a clear understanding about the needs for the traffic engineering services. An effort should therefore be made to inform the governing bodies of the cities and towns why traffic engineering services are needed and what the laws of the state require in regards to traffic engineering and local traffic control devices. The governing bodies of the cities and towns should also be made aware of the possible legal liabilities resulting from traffic accidents and nonconforming traffic control devices.

In many of the cities and towns surveyed, the traffic commission of the city or town must approve the erection or removal of any of the traffic control devices within their community. The members of such a traffic commission, in order to make these decisions, must possess the knowledge of why a particular traffic control device is or is not needed and what the possible effects of the erection or removal of the traffic control device will be. The erection of an unwarranted traffic control device may

unnecessarily cost the community in terms of material, labor, delay and energy consumption. On the other hand, the unwarranted traffic control device may be disrespected by the motorist because of the unreasonableness of the regulation required of the traffic control device.

It is therefore recommended that the members of traffic commissions be encouraged to increase their knowledge of the basics of the usage and effects of traffic control devices.

During the personal interview with the persons in charge of the traffic engineering functions, it was observed that very few of them were aware of the availability of grants from the Highway Safety Annual Work Program in the areas of police traffic services and traffic engineering services through the Indiana Department of Traffic Safety and Vehicle Inspection. It is therefore recommended that the Indiana Department of Traffic Safety and Vehicle Inspection make special effort to inform each city and town of the grants and services available each year from the Highway Safety Annual Work Program and also to inform them of the basic requirements necessary in making grant applications.

Some of the cities and towns visited have had inventories of their traffic control devices and high accident location studies conducted by consultants with funding through grants from the Indiana Department of

Traffic Safety and Vehicle Inspection. A few of these cities have used these inventories to demonstrate the need for additional financial aid from the Indiana Department of Traffic Safety and Vehicle Inspection for the purchasing of regulatory and warning signs. However, there were a few instances where the person in charge of the traffic engineering functions stated that he did not know what was even contained in the inventories of the traffic control devices or the high accident location studies. In many cases, the inventories had not been continually updated or looked at since they had been completed. It is therefore recommended that the Indiana Department of Traffic Safety and Vehicle Inspection require as part of the application procedure a comprehensive and practical plan for use of the requested studies and inventories before any grant is approved.

Traffic Engineering Organizational Guidelines

The need for any level of the technical and administrative capability required to operate an effective traffic safety program depends primarily on the population size and characteristics of the community. The specific requirements can usually be determined from knowing the following information.

1. Roadway mileage controlled by the particular political subdivision.

2. Volume of traffic on roadway system.
3. Number of operational problems or accidents.
4. The extent of urban development within and surrounding the local jurisdiction.

The Highway Safety Program Manual No. 13⁵ presents general organizational guidelines only for those political subdivisions whose population is greater than 25,000 persons. The guidelines for those cities and towns of 25,000 to 50,000 population are presented below.

Communities of 25,000 to 50,000 Population.

1. The department of public works or its equivalent should be given primary responsibility for the traffic function.
2. A minimum of one technician should be trained in traffic control techniques related to operation, maintenance, and evaluation.
3. In addition to performing regular traffic engineering functions . . . the department should
 - a. Set up procedures for utilizing traffic engineering services available through consulting or governmental agencies.
 - b. Provide specialized training for technicians through short courses or their equivalent.
 - c. Work with the police department to obtain police traffic support, including school crossing protection and emergency traffic control.
 - d. Utilize the news media and service organizations in disseminating information of public interest.
 - e. Jointly develop with the school district, school bus routes, safe routes to school, and safety education programs.⁶

For the political subdivisions of less than 25,000 population, the organizational guidelines would be almost the same as those presented above. The only differences would be in the number of persons with traffic control technique training and the amount of training that they receive. As the population size of municipalities decreases, the amount of traffic engineering training needed to perform the required functions decreases. What is more important for the smaller urban areas is an effective records keeping procedure as well as the knowledge of the source of needed information. The Indiana Manual on Uniform Traffic Control Devices⁷ contains sufficient information needed to do the very basic traffic engineering functions. More complicated problems can be resolved with the aid of a good traffic engineering references book or by the hiring of a part-time consultant.

It is interesting to note that in many of the cities and towns visited, the traffic safety officer performed many of the traffic engineering functions. However, the role of the police department should be that of record keeping of the accident inventory, traffic law enforcement, coordination in school route protection, and informing the person in charge of the traffic engineering functions of possible problem areas. It was observed that a few of the traffic safety officers had to spend a large part of their time in traffic engineering work. **-It is felt that**

such a situation is not a cost-effective usage of their police training.

Recommendations for Further Studies

In order to determine the extent to which the conformance of the traffic signs influence accidents and accident rates, further study can be conducted to determine before and after accidents and accident rates for those cities that have taken advantage of the Highway Safety Annual Work Program to purchase new traffic signs to fully meet the standards as set forth in the Indiana Manual on Uniform Traffic Control Devices. In addition, the sampling technique used in this study for the determination of the conformance of the traffic control devices can be compared with completed inventories of the traffic control devices so as to determine if this technique can be used as a quick method to rate the cities and towns according to their compliance with the standards.

Concluding Remarks

The main result as determined by this study was that in general, as the population size of the municipality decreases, so does the quality and quantity of the traffic engineering functions performed. Although the decrease can be partially attributed to the less complexity of the traffic problems in the smaller urban areas, a significant reason for this poor level of traffic engineering is the

lack of the needed knowledge. In this aspect, the following items were observed to be most recurrent.

1. Not knowing that a manual on uniform traffic control devices exists.
2. Not knowing how or where to send for a manual.
3. Not knowing how to perform a particular traffic engineering function.
4. Not knowing where to find out how to perform a function.
5. Not knowing what is required of the city or town in regards to traffic engineering and local traffic control devices by the Indiana State Statutes.
6. Not knowing what type of aid is available from the Indiana State Highway Commission or the Indiana Department of Traffic Safety and Vehicle Inspection.

If the level of traffic engineering in small urban areas is to improve, it is essential that an effort be made to provide these municipalities with the necessary tools and knowledge needed to effectively perform the traffic engineering functions.

NOTES

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2. U.S. Department of Transportation, Federal Highway Administration, Manual on Uniform Traffic Control Devices, (Washington, D.C.: Government Printing Office, 1971).
3. National Committee on Uniform Traffic Laws and Ordinances, Uniform Vehicle Code and Model Traffic Ordinance, (Charlottesville, Va.: The Michie Company, 1968; Supplement I, 1972).
4. Ibid.
5. U.S. Department of Transportation, Federal Highway Administration, Highway Safety Program Manual, Vol. 13, Traffic Engineering Services (Washington, D.C.: Government Printing Office, 1974), pp. VI-1-V I-2.
6. Ibid.
7. Indiana State Highway Commission, Indiana Manual on Uniform Traffic Control Devices, (New edition to be published in 1976).

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APPENDICES

Appendix A

Traffic Engineering Survey of Small Cities and Towns

To be filled out by the person in responsible charge of the traffic engineering functions in your city or town.

Please provide, as best as you can, the following information on your city or town.

I. Traffic Engineering Administration and Personnel

1. Name of city or town. _____
2. Name of the person presently in charge of the traffic engineering functions. _____
3. Are you a full time employee of the city or town or a regular part time consultant? _____
4. Title. _____
5. Department. _____
6. Office telephone number. _____ - _____ - _____
7. To whom or what body are you directly responsible to? Give title. _____
8. Where did you receive your traffic engineering background?
 - ___ A. University or College Degree Program
 - ___ B. Conferences, Seminars, or University Courses
 - ___ C. On the Job Experience
9. Please indicate what percentage of your time (or number of man-days per year) you devoted to traffic engineering in your city or town during the year 1974. _____

10. If you have other duties other than that of traffic engineering in your city or town, please list them. _____

11. Did your city or town receive additional assistance in traffic engineering in the form of traffic engineering personnel from a public agency, private firm, or consultant during the year 1974?

Yes _____ No _____

12. If the answer to Question 11 is "yes", please indicate from whom your city or town received additional assistance.

___ A. County
___ B. State
___ C. Private Firm
___ D. Consultant

II. Traffic Accident Records - Local Streets

1. Total number of accidents at intersections of local streets (do not include state highways) within the city or town during the year 1974. _____
2. Total number of accidents at signalized intersections of local streets (do not include state highways) within the city or town during 1974. _____

III. Quality of Traffic Engineering

1. How would you rate the quality of traffic engineering in your city or town in regards to those areas within local jurisdiction?

___ 5 Excellent
___ 4
___ 3 Adequate
___ 2
___ 1 Poor

IV. Traffic Control Devices (Under Local Control, that is Traffic Control Devices Not on State Highways)

In your opinion, how would you rate the following traffic control devices located in your city or town.

| <u>Traffic Control Device</u> | <u>Overall Physical Condition of the Devices</u> | <u>Conformance of the Devices to the 1970 "Manual on Uniform Traffic Control Devices"</u> |
|-------------------------------|--|--|
| A. Signs | Poor . . . 1 <u> </u> 2 <u> </u> 3 <u> </u> 4 <u> </u> Excellent 5 <u> </u> | Unknown . 1 <u> </u> Poor . . 2 <u> </u> 3 <u> </u> 4 <u> </u> 5 <u> </u> Complete 6 <u> </u> |
| B. Signals | Poor . . . 1 <u> </u> 2 <u> </u> 3 <u> </u> 4 <u> </u> Excellent 5 <u> </u> | Unknown . 1 <u> </u> Poor . . 2 <u> </u> 3 <u> </u> 4 <u> </u> 5 <u> </u> Complete 6 <u> </u> |
| C. Markings | Poor . . . 1 <u> </u> 2 <u> </u> 3 <u> </u> 4 <u> </u> Excellent 5 <u> </u> | Unknown . 1 <u> </u> Poor . . 2 <u> </u> 3 <u> </u> 4 <u> </u> 5 <u> </u> Complete 6 <u> </u> |

V. Traffic Engineering References

1. Do you or your office have a copy of the 1965 Traffic Engineering Handbook compiled by the Institute of Traffic Engineers? Yes No
2. Do you or your office have a copy of the Indiana State Manual on Uniform Traffic Control Devices or the U. S. Department of Transportation. Federal Highway Administration, 1970 Manual on Uniform Traffic Control Devices? Yes No

VI. Maintenance of Signs, Signals, and Markings

1. If a breakdown of labor and costs for maintenance of signs, signals, and markings separately is not possible, then please give the total number of man-days and costs during the year 1974. (Costs include material and labor costs in dollars.) If a breakdown is possible, answer Question 2.

Man-days _____ Costs \$ _____

2. Break-down of labor and costs for maintenance of signs, signals, and markings during the year 1974.

| | Man-days | Costs (\$) |
|----------|----------|------------|
| Signs | _____ | _____ |
| Signals | _____ | _____ |
| Markings | _____ | _____ |

VII. Special Financial Assistance

1. If your city or town has received any type of special financial assistance, State or Federal, for any type of traffic related improvements or studies between the years 1970 thru 1974, such as TOPICS, please give the program name, funding agency, purpose of assistance, and the amount of financial assistance.

VIII. City or Town and the Indiana State Highway Commission

1. How would you rate the coordination and cooperation between your city or town and the Indiana State Highway Commission in regards to the traffic control devices (signs, signals, and markings) located on the state highways within your municipality? (1 low - 10 high) ____

Comments? --

2. How would you rate the effectiveness of the traffic control devices located on the state highways within your city or town? (1 low - 10 high) ____

Comments? --

IX. Sources of Aid

1. In what ways do you think the following institutions could aid your city or town in the area of traffic engineering, whether this aid be financial, personnel, technical, or educational?

Your City or Town Council

Your County

Indiana State Highway Commission

Federal Highway Administration

Purdue University School of Civil Engineering
Transportation Engineering Division

X. Traffic Problems

Rate the following traffic problems in your city or town in accordance with the concern of the community at present.

5 Great Concern

4

3 Some Concern

2

1 Little or No Concern

- ☐ A. Inadequate Parking in the Commercial Area
- ☐ B. High Accident Locations
- ☐ C. School Crossings
- ☐ D. Traffic Congestion
- ☐ E. Traffic in Residential Neighborhoods
- ☐ F. Pedestrian-Auto Conflict
- ☐ G. Bicyclo-Auto Conflict
- ☐ H. Other

XI. Additional Questions

1. Does your city or town have an advisory traffic committee, commission, or board? Yes___ No___
2. Does your city or town have a regulatory traffic committee, commission, or board that has authority to implement decisions? (Other than city council or town board) Yes___ No___
3. Indicate your need for the following items that would be most helpful to your city or town in regards to traffic engineering.
 1. None or Little Need
 2. Some Need
 3. Great Need
 - ___ A. Additional Personnel
 - ___ B. Additional Equipment
 - ___ C. Additional Materials
 - ___ D. Additional Geometric Improvements
 - ___ E. Additional Technical Information
 - ___ F. Other
4. How would you judge the understanding of your city or town governing body with regards to the needs for traffic engineering services? (Check one.)
 - ___ 1. No understanding
 - ___ 2. Slight grasp
 - ___ 3. Adequate understanding
 - ___ 4. Knows it well

Traffic Engineering Survey of Small Cities and Towns

Traffic Engineering Functions

I. Plans

| | <u>Parking Plan</u> | <u>Master Street Plan</u> | <u>Truck Route Plan</u> |
|--|-------------------------|-----------------------------------|---------------------------------|
| Does your city or town have or done a | _____ | _____ | _____ |
| Who has the responsibility for the determination of the needs and requirements for the | _____ | _____ | _____ |
| Periodically updated (P) or when deemed necessary (WDN) | _____ | _____ | _____ |
| If periodically, how often? | _____ | _____ | _____ |

II. Studies and Surveys

| | <u>Exists or have done</u> | <u>How often performed</u> | <u>Responsibility for performing the study</u> |
|-----------------------------------|--------------------------------|--------------------------------|--|
| Travel Time and Delay Studies | _____ | _____ | _____ |
| Spot Speed Studies | _____ | _____ | _____ |
| Parking Demand and Supply Studies | _____ | _____ | _____ |
| Origin and Destination Studies | _____ | _____ | _____ |
| High Accident Location Studies | _____ | _____ | _____ |

| | | | |
|------|--|--|---|
| III. | Curb Use | <u>Determination of need, design, and location</u> | |
| | Parking Meters | _____ | |
| | Parking Restrictions | _____ | |
| | Loading Zones | _____ | |
| | Bus Stops | _____ | |
| | Municipal Off-street Parking . | _____ | |
| IV. | Traffic Control Devices | <u>Determination of need, design, and location</u> | <u>Maintenance performed by</u> |
| | Channelization | _____ | _____ |
| | Regulatory Signs | _____ | _____ |
| | Warning Signs | _____ | _____ |
| | Directional Signs | _____ | _____ |
| | Street Name Signs | _____ | _____ |
| | Traffic Signals | _____ | _____ |
| | Pavement Markings | _____ | _____ |
| | Turning Restrictions | _____ | _____ |
| | School Route Protection | _____ | _____ |
| V. | Miscellaneous | | |
| | Curb Openings - Who grants permits? | _____ | |
| | Parades and Special Events - Who coordinates traffic? | _____ | |
| | Street Lighting - Who determines need and location? | _____ | |
| | Who performs maintenance? | _____ | |
| | Geometric Design - Who does the designing or checking of street geometrics? | _____ | |

| VI. | Inventories | | | |
|-----|-----------------|--------------|-------------------------------|--|
| | | <u>Exist</u> | <u>How often updated?</u> | <u>Responsibility for updating</u> |
| | Street | _____ | _____ | _____ |
| | Traffic Signals | _____ | _____ | _____ |
| | Signs | _____ | _____ | _____ |
| | Markings | _____ | _____ | _____ |
| | Traffic Volumes | _____ | _____ | _____ |
| | Accidents | _____ | _____ | _____ |

Appendix B

Suggested Forms of Traffic Engineering Assistance from Different Government Institutions

City or Town Council

"Continued support in budget approval for additional manpower, equipment, and materials."

"The city council could pass ordinances to establish a local thoroughfare fund on the same order as an accumulated building fund so new streets could be built."

"More attention given to importance of proper and uniform signs and markings."

"Technical and educational (aid)."

"Financial and technical (aid)."

"Provide more funds for training and improvements. Set out a program of improvement for (x) number of intersections a year, etc."

"Give more money to work with in budget . . . "

Indiana State Highway Commission

"Continued technical assistance and cooperation."

"Better understanding of the problems that exist in the smaller communities---."

"Perhaps help in advisory position as to better engineering practices in small town traffic engineering problems."

"More assistance in actual mechanics of funding. More cooperation between ISHC (Indiana State Highway Commission) and local units in planning."

"State Highway Commission could hold more seminars."

"Cooperate with the city in financial, personnel, technical, and educational aid."

Purdue University
School of Civil Engineering,
or Joint Highway Research Project

"(Cooperative) employment of undergraduate and graduate students with traffic engineering education - summer, part time."

"Expanded seminars for technicians, perhaps on a regional basis."

"Perhaps same as S.H.C. (help in an advisory position) and more technical manuals for small towns."

"Perhaps some traffic engineering courses in conjunction with the local IU (Indiana University) campus."

"Send us recommendations and other information in reference to traffic safety."

Federal Highway Administration and the
National Highway Traffic Safety Administration

"Make matching money available to the nonmetropolitan communities for updating the signals and improving the major arterial roadway system."

"Need assistance in availability of and mechanics of applying for assistance."

Appendix C
Cities and Towns Surveyed

A list of the cities and towns surveyed is presented in this appendix. The population ranges used in this list are shown below.

| | |
|--------------------|-----------------|
| Population Range 1 | 2,000 - 9,999 |
| Population Range 2 | 10,000 - 19,999 |
| Population Range 3 | 20,000 - 50,000 |

| <u>City or Town</u> | <u>Population Range</u> |
|---------------------|-------------------------|
| Bedford | 2 |
| Bloomfield | 1 |
| Brazil | 1 |
| Columbus | 3 |
| Connersville | 2 |
| Crawfordsville | 2 |
| Danville | 1 |
| Edinburg | 1 |
| Elkhart | 3 |
| Fairmount | 1 |
| Fowler | 1 |
| Frankfort | 2 |
| Franklin | 2 |
| Kendallville | 1 |
| Kokomo | 3 |
| Lagayette | 3 |
| LaPorte | 3 |
| Linton | 1 |
| Martinsville | 1 |
| Mishawaka | 3 |
| Monticello | 1 |
| Richmond | 3 |
| Shelbyville | 2 |
| Warsaw | 1 |
| West Lafayette | 2 |
| Winamac | 1 |

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